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Dyslexia and Time:
A comparison of speed and accuracy of young dyslexics and non-dyslexics on time recognition and time management by adult dyslexics

Thesis submitted in accordance with the requirements of the University of Chester for the degree of Doctor in Philosophy

By

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August 2013

ABSTRACT

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Dyslexia and Time: A comparison of speed and accuracy of young dyslexics and non-dyslexics on time recognition, and time management by adult dyslexics

This research describes two investigations into temporal processing by dyslexics. Firstly, the accuracy and speed of response that dyslexic children and matched controls demonstrate on three types of time comparison task was explored. The participants were 96 boys and 24 girls, divided into three age bands: 7:0 – 7:11; 11:0 – 11:11 and 14:0 – 14:11 years of age of whom 60 were dyslexic and 60 non-dyslexic. Dyslexics in all age bands took longer and made fewer correct responses than non-dyslexics in time telling. Younger dyslexics were differentially disadvantaged when compared to older dyslexics in speed and correctness. Both groups showed improved accuracy and speed with age. The dyslexic cohort aged 14 years improved in accuracy from age 11, though with only a marginal improvement in reaction time speed. Complex time perception proved most difficult for both groups. Reasons for these differences are discussed with reference to limited short-term memory problems affecting performance especially for dyslexics. The research substantiates particular theories of dyslexia and a new model helps to explain the process. Practical implications are suggested for parents, teachers and examiners concerned with dyslexic children. Secondly, the time management skills of dyslexic and non-dyslexic adults were examined for 43 dyslexic and 41 non-dyslexic participants who answered an online questionnaire about their time management skills. The adult questionnaires revealed that dyslexics find time management, estimation, planning and sticking to a schedule particularly difficult, resulting in task delay or incompletion, and heightened levels of stress as time pressures increase. Questions revealed lack of confidence in time management techniques amongst dyslexics. Many dyslexics had found these difficulties placed severe constraints on career choices, areas of employment and lifestyle. Possible reasons for these differences are discussed with an accompanying model that stresses the constraints caused by poor working memory.

DEDICATION

This thesis is dedicated to my parents, Leonard and Freda Ellis, and to Sula, my wife. Without their guidance, support and inspiration, this research would never have been initiated let alone completed.

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University of Chester

Disclaimer

This work is original and has not been submitted previously for any academic purpose. All secondary sources are acknowledged.

Signed:

Date: 19th August 2013

Preface

Time telling as a child was difficult for the author of this research, and as an adult, time management has its challenges. As the author is dyslexic, he wished to discover if dyslexia affected time telling and time management skills and indeed, if other dyslexics experienced similar difficulties. Having an interest in time and time management through his MBA studies led him to investigate the nature of past research in time and time management and if any had been carried out with dyslexic participants. It soon became apparent that there was a paucity of research in the subject.

Chapter 1 Introduction

1.1 Focus of the Research

The author has eighteen years of experience teaching dyslexic children and adults both in language acquisition and mathematics. What was clear was that time telling presented unique problems for many of the children taught. Much more preparation, guidance and practice were required for them to master their skill. For young adult dyslexics helped by the author, the circumstance of how to follow time management strategies commonly occurred in support of demands at school and in college.

The author too, had difficulty in managing time effectively when studying for his engineering degree at university thirty years ago. The timetabling of lectures and content demands of the course required much more time planning to keep on track. Thus, organising time effectively became a major task in itself. It appeared that other students found organising their time easier while the author found it challenging. Often the author would take longer to compose an essay or write up a piece of research which placed pressure on completing other course related tasks on time, and this led to shorter nights of sleep and little time to relax. These were very demanding times which needed close management. The author thought this kind of scenario was particular as others seemed to cope.

As the author has worked in the field of dyslexic teaching for some time, this has created a unique opportunity to observe the time practices of others, both for children and adults. The adult students have needed to be given guidance in developing time management skills and have received coaching and support to help with the demands of academic projects. In addition, a number of parents of pupils who are known to be dyslexic have been able to share their difficulties in organisation when their offspring have been taught supportive techniques. It was apparent, therefore, that adults did indeed show signs of the organisational skill deficiencies that the researcher had experienced at university.

The author found the observations of other dyslexic people reminiscent of personal experiences and so embarked on this study to expand the knowledge base of dyslexic research. Consequently, it is envisaged that the results would, in the long term, help to give teachers and practitioners a clearer understanding of the difficulties experienced by dyslexic children in learning time, the age of acquiring skills and other observed characteristics which could help to improve teaching to these groups of people. For adults, it might provide a forum for understanding of time management that could benefit dyslexic people.

1.2 Thesis Outline

Chapter 2 is entitled the Literature Review and begins with an outline of time telling and the research that has taken place considering the skill required in developing time telling proficiency. There is a paucity of research specifically in the field of dyslexia and time telling, which this research aims to address. There is a wealth of literature concerning dyslexia which is presented in some detail later, with an emphasis on the aspects of dyslexia which are likely to impinge on the developmental skills required for time telling understanding.

The broad nature of the research in dyslexia has focused mostly on phonological difficulties and acquisition of phonological skills. Further, the research reported in this thesis provides supporting evidence of research in mathematics and in memory with a review of research, for example, by Geary and Brown (1991), and Andersson (2008). The link between dyslexia and time telling is considered in the context of dyslexic and mathematics type difficulties. In addition, the understanding of time telling maturation is supported by a number of researchers (Andersson, 2008, 2010; Burny, Valcke, & Desoete, 2009, 2011; Friedman & Laycock, 1989).

The research literature is presented in two units in accordance with experimental parts of the thesis (child and adult) and provides the thread of thought relevant to the project. Unit 1 considers in depth the understanding of time telling in young children and the observations made by other researchers in children's acquisition of both analogue and digital time. Research in support of language acquisition and visual constituents are considered, together with schemes of time telling that researchers have noticed. An outline of dyslexia is presented and the syndrome is considered in detail. Key areas of time telling observed by other researchers and its co-occurrence with dyslexic type difficulties and mathematics difficulties in children, is offered.

The researcher found it important to consider the role of co-occurrence of other deficits within the profile of learning difficulties in order to outline the possible connection that these co-occurrences may have with time telling skill acquisition.

Examination of the research into rapid naming and memory processes is offered as an essential component of time telling proficiency in dyslexia; as the demands placed on retrieval of time telling information speculatively require efficiencies in both these cognitive skills.

This research identifies a number of similarities between other researchers (Geary & Hoard, 2001; Jordan, Hanich, & Kaplin, 2003; Turner Ellis, 2002) who found that dyslexic children were slower and less accurate in mathematics number fact retrieval. Further, similarities observed in other researchers' work relating to digital time and analogue time performances is reported (Burny et al., 2009, 2011; Friedman & Laycock, 1989; Korvorst, Roelofs, & Levelt, 2007).

Unit 1 concludes with the position the author has reached on the concept of time telling knowledge and outlines four primary research questions.

Unit 2 describes in detail the research associated with time management principles used by adults in their everyday life. The link with time telling is offered and explanations of the functions of time management principles connected with time telling are presented. There is a paucity of research specifically in time management and dyslexia, though the concept of time management is expounded. It is referenced and linked to the cognitive profile of dyslexia in a way that supports the anticipated difficulties that dyslexia has on time management processes.

The questionnaire devised for this part of the thesis sought to examine time management principles used by dyslexics, based on the experiences of the researcher. Weaknesses associated with cognitive interference, planning fallacy and time discounting contribute to the added problems reported by the dyslexic cohort. Research has taken place in recent years to consider the role of technology and study skills (Kirby, Silvestri, Allingham, Parrila, & La Fave, 2008) as more dyslexic young people move into higher education. A section has been integrated in the questionnaire to study this.

Consideration is also given to the negative effect that time management deficiencies may have in the dyslexic profile, in particular self-esteem, stress and anxiety. Similarities between the outcome of this research and the observations of other researchers relating to stress and self-esteem are presented.

The opportunity to learn more about adult decision making connected to career path choice is also explored as it is speculated that dyslexia may play a role in the selection of a career.

Unit 2 concludes with the position the author has reached on the longitudinal effect and role of general time telling and time management into adulthood. This leads to the formulation of seven primary research questions.

Chapter 3 (Section 1) describes the child Time Comparison Task experiment and how the methodology used in this research was chosen and the ethical considerations which took place. The rigorous approach to participant selection and the safeguards adopted to control for co-occurrences of some learning difficulties, such as attention deficit (hyperactivity) disorder (AD(H)D), are presented.

The choice of times to be measured based on children's skill level and the three mathematical key stage levels, is offered. The justification for adopting a quantitative approach rather than a qualitative approach is reviewed.

Later in this chapter, the results of the accuracy and reaction time of responses are analysed and are presented and summarised in the context of the hypotheses. It is seen that the reaction times and accuracy of responses for the dyslexic participants differ from that of their control group counterparts across the three age bands selected. Examples of the raw data are provided in the Appendix to illustrate to the reader the analytical methodology used and how the findings were reached.

Chapter 4 presents a transitional platform between the Time Comparison Task experiment (Chapter 3) and the Adult Time Management Questionnaire (Chapter 5). It offers a literature review extension to enable the two sections of the research to unite.

Chapter 5 (Section 2) describes the methodology and analytical processes involved in designing the adult questionnaire. The participant selection and the safeguards adopted are discussed. The choice of questions in the questionnaire and the justification for adopting a mixture of qualitative and quantitative approaches in the analysis are considered. In this chapter, the results of the adult questionnaire are analysed and presented and the written responses from participants are published. Examples of data are offered in the appendix section of the thesis, together with additional written responses from participants.

Reflecting upon the literature review, Chapter 6 discusses the outcome of the questions for the reaction time experiment and for the questionnaire in separate sections and provides evidence in support of two models, one for each of the research outcomes. The first model offers an explanation towards the understanding of time telling in children with dyslexia. It clearly presents reaction time and accuracy differences with age and postulates the likely approaches dyslexic and non-dyslexic children take in the learning of time.

The second model refers to the differing time management approaches that have emerged between the dyslexic and non-dyslexic adults. Explanation of these differences is given in this chapter.

Chapter 7 draws together the similarities within this research with the literature review and offers a theoretic and practical critique of the research findings. The chapter concludes with ideas for future research to enable the expansion of knowledge in this interesting area.

Chapter 2 The Literature Review

2.1 Introduction

The Literature review is presented in two units. Unit 1 addresses the literature specifically concerning time telling and dyslexia. An overview of time telling and the respective skills needed to develop the ability are presented first, followed by an examination of dyslexia and the associated deficits linked with the syndrome. At the end of this unit, the research questions are established. Unit 2 addresses the literature in connection with adult time management. The research questions established for this unit and presented at the end have been derived as a result of the supporting evidence from the literature review.

Unit 1 Time Telling and Dyslexia

2.1.1 Time Telling

Time telling is a skill which affects our daily life and in recent years has received more attention by researchers (Burny, et al., 2009, 2011). The skills needed to understand the concept are numerous and varied, and include familiarity with jargonistic language and vocabulary (Harner, 1981), sequencing, visuo-spatial skills (Eden, Wood & Stein, 2003), understanding of symbolic representations, and skills in translating from analogue to digital time and vice versa. Further, the ability to tell time requires mathematical competences akin to mental arithmetic skills and is a complex area of mathematics for children to master (Andersson, 2008, 2010; Friedman & Laycock, 1989). It comprises a number of different concepts such as counting skills together with procedural practices (Andersson, 2008; Friedman & Laycock, 1989). Moreover, for children to be successful in time telling, a number of key components are required to merge such as numeracy and literacy (Foreman, Boyd-Davis, Moar, Korallo, & Chappell, 2008).

To develop and improve mathematics competency in time telling, three important constituents are required, which will be presented next. The first is language acquisition which is an essential component for successful communication of an idea or concept between individuals. Mathematics represents a language in itself to convey principles in problem solving. Mathematics concepts and procedures are taught using this language in a concrete fashion to develop ideas and promote understanding. Reinforcement is achieved through practice to promote mathematics competency for longitudinal progression onto more demanding mathematics ideas. The second important constituent relates to visuo-spatial skills with particular reference to visuo-perceptual skills (Eden et al., 2003; Geary, 2004). The third constituent involves memory which plays a pivotal role in mathematics and time understanding.

2.1.2 Language Acquisition

There is supporting evidence from a number of researchers suggesting that clock reading requires a complex array of language to convey meaning (Hoodless, 2002; Korvorst et al., 2007). Further, telling and writing time follows capricious rules which require mastery to convey the vocabulary successfully (Korvorst, et al., 2007). Korvorst et al. (2007) presents a three stage process for an individual to read time. The first is conceptual formulation involving analysing reference points such as hours, quarter and half hour intervals. The second process involves choosing the language to convey what is to be described in the correct order, called lemma and syntax, and the third is form encoding. This is the articulatory stage which by using phonemes and morphemes retrieved from memory; an individual is able to convey the symbolic representation of time to language. In dyslexia research, weakness in articulation is well documented (Kasselimis, Margarity, & Vlachos, 2008; McDougall & Donohoe, 2002) with respect to language acquisition and rapid automatic naming (Wolf & Bowers, 1999) which is explored later.

2.1.3 Visuo-spatial Constituents

It is acknowledged between researchers that there is a link between an individual's visuo-spatial awareness and mathematics competency (Casarotti, Miccielin, Zorzi, & Umiltà, 2007; Geary, 2004). Studies have been undertaken to compare the performance of children with known mathematics difficulties against those who have not and the results support the notion that visuo-spatial anomalies have emerged in the group displaying mathematics difficulties. There is, however, evidence beginning to be presented from new research (Raghubar, Barnes, & Hecht, 2010) challenging a connection between visuo-spatial competence and mathematics difficulties. This will, no doubt, lead to further debate.

What is clear is that to translate a pictorial presentation, such as an analogue clock, and to decipher its meaning from that presentation, and to represent a symbolic reference verbally, requires a plethora of skills. Further, to achieve this successfully and at speed requires coordination that takes time to master, and which can be underestimated in mathematics understanding and teaching.

2.1.4 The Role of Memory in Time Telling

Given that there are seven hundred and twenty possible permutations of time to the nearest minute, presented on an analogue clock face, competency requires substantial memory resources. Procedural approaches in mathematics encompass sound understanding of concepts and memory for methodology (Geary & Brown, 1991). Children will show immature procedural strategies if they do not completely understand concepts and if their memory for fact retrieval, processes or relevant vocabulary is lacking (Andersson, 2008, 2010; Friedman & Laycock, 1989; Geary, 2004). When considering the role of memory in learning to tell time or solving mathematical problems there is an overlap of memory components. Short-term or working memory provides for the immediate support of problems presented and long-term memory gives an individual the opportunity to retrieve information connected with solving the problem. Retrieval approaches suggest mastery of a task and lead to automaticity towards an answer (Burny et al., 2011; Case, Sandieson, & Dennis, 1986).

2.1.5 Schemes for Time Telling

As with other areas of mathematics, telling time requires knowledge of concepts and processes (Geary & Hoard, 2005; Rittle-Johnson, Siegler, & Alibali, 2001). Conceptual understanding requires familiarity with clock facts to support identification (Burny et al., 2011) such as minutes in an hour, scaling of the clock face, and the hour, minute and second hand. In addition, recognising anchor points such as the o'clock, quarter and half positions on the clock face (Friedman & Laycock, 1989), or the meaning of zero in the digital clock are essential abilities.

Processes involved with time telling comprise skills from elsewhere in mathematics such as counting, number retrieval, and sequencing (Burny et al., 2011; Friedman & Laycock, 1989; Siegler & McGilly, 1989). Calculation procedures were reported by Friedman and Laycock (1989) when telling time for both analogue and digital presentations. Siegler and McGilly (1989) thought that counting strategies were adopted to answer questions involving analogue time. What is apparent is that a combination of conceptual and procedural approaches should be adopted to enable successful time telling.

When evaluating time telling as a processing mechanism, there are a number of important factors to consider for the process to be achieved. Time can be presented in two distinct formats and as these are likely to an interchangeable, the requirement to understand both formats is essential. The hardest format is the analogue clock as there are a number of key elements to master just to be able to read the clock. For that process to begin, young children are presented with limited but cumulative principles when taught, together with supporting vocabulary and syntax which is age appropriate. In teaching, children are shown time telling through a step-by-step approach both on a concrete level, by manipulating the hands of the clock to present time, and by connecting descriptions of time with aspects such as o'clock and periods of the day, month and year. These early concepts are presented at age five and six, just at a time when phonics teaching is in its infancy. Alphabet sounds are developing; articulation is improving, and remembering sound and letter links is progressing at a tangible pace. Vocabulary from different areas of school and home are being absorbed to help children to communicate.

Some children will find this new plethora of language difficult while others will find it easy, making connections as they improve with their skills. Others will receive additional support at school or at home, and some youngsters might even receive help with speech and language issues. The one circumstance that they all have in common if they are in the classroom is that they are receiving the same information at around the same time, though each child may present a different profile for learning. Everyone will learn at different rates, some will forget, some will need guidance, some will respond and some will not. In the case of the children with dyslexia, their progress might be delayed as more time is needed to comprehend the language around them.

The following section considers dyslexia in a global sense in the classroom and provides an image of the difficulties experienced by these children that may affect their schemes in telling time.

To understand the effect that dyslexia might have on a child, it is worth considering the typical profile. Characteristically, dyslexia manifests itself through a weakness in phonological skill development. Children find it difficult to connect the grapheme-phoneme correspondence necessary to develop reading and spelling skills through alphabet acquisition (Vellutino, Fletcher, Snowling, & Scanlon, 2004). Vellutino et al. (2004) highlight three primary aspects of phonological processing affecting dyslexic children which combine to become a principal deficit:
1. phonological sound manipulation – being able to hear sounds, process them accurately, blend them together and repeat them back; 2. having memory for sounds that are presented verbally and; 3. being able to name letters and blends of letters when presented visually. The author of this thesis has observed dyslexic children of high intellectual ability reciting the alphabet with consummate ease, but struggling to name individual letters which are presented to them randomly. Also, and this often happens, the same children who find it difficult blending sounds

together, continually make the same mistake with the same blend even though they know they are incorrect. Likewise, the confusing array of time telling vocabulary presents a challenge in connection with phonological processing, articulation and recall. Certainly, an intelligent child who is articulate and able to prove strengths in mathematics computation, visual understanding, non-verbal encoding skills and long-term memory, and yet show problems with short-term memory, rapid retrieval skills, reading and spelling, is going to be noticed by teachers.

Other observations made by researchers of dyslexic traits which appear at a young age are the inability to rapidly name objects, such that retrieval from memory appears to present difficulties (Pennington & Bishop, 2009). Being able to identify times and to retrieve descriptive words rapidly to explain the time is likely to cause difficulty. In children and adults, substitutions will occasionally occur such as ‘thingy’ to enable something to be said in responding to an object name. This helps the recipient to appreciate that communication is taking place and not be faced with silence as the dyslexic processes information and searches for the right word to say.

Under some circumstances children begin to feel that they are failing, particularly as they so often compare themselves with their peers to monitor their own progress in the school environment (Fuchs & Fuchs, 2006). This can happen very early on in the academic career of a dyslexic child. For example, researchers carrying out longitudinal studies on dyslexic children at age eight report of observing weaknesses in letter familiarity and phoneme knowledge at age four to six (Scarborough, 1990; Snowling, Gallagher, & Frith, 2003). Given the potential level of difficulty in time telling, any weakness is likely to be noticed by peers within the class. Often children with undiagnosed and untreated difficulties experience frustration and a feeling that they are not able to do what is asked, which when left unattended leads to avoidance.

Interpretation of these studies has resulted in recommendations to teachers in schools in the United Kingdom to monitor the progress of children with phonics skill development over a three year development window (Rose, 2006).

To consider the impact that dyslexia has on a child’s learning, the next sections present in greater detail the research attributed to specific areas of weakness including phonology and theories relating to dyslexia, such as magnocellular deficit theory, automatisation, rapid naming, the role of the cerebellum, articulation and memory.

2.2 Overview of Dyslexia

Dyslexia has been studied by a number of researchers over the past one hundred years in order to understand the nature and cause of the deficit among children and adults. It is a lifelong disorder affecting fluency in reading and spelling and is described as a discrepancy between reading ability and intelligence in children who receive reading tuition. In order for better understanding, researchers have evolved with their research from considering the observational differences between a dyslexic and a non-dyslexic to examining the physiological aetiology.

The British Dyslexia Association's latest definition (2007) suggests dyslexia is:

> "... a specific learning difficulty that mainly affects the development of literacy and language related skills. It is likely to be present at birth and to be life-long in its effects. It is characterised by difficulties with phonological processing, rapid naming, working memory, processing speed, and the automatic development of skills that may not match up to an individual's other cognitive abilities. It tends to be resistant to conventional teaching methods, but its effect can be mitigated by appropriately specific intervention, including the application of information technology and supportive counselling."

Miles (1983) refers to dyslexia as a syndrome which encompasses a number of characteristics that in isolation present few difficulties but when combined can cause serious problems for the acquisition of language.

In considering the topography of dyslexia it appears to be reasonably common and estimated to affect 5% to 17.5% of the general population (Shaywitz, 1998) with the variability being attributed to differences in the definition and the testing criteria adopted between languages (Lindgren, De Renzi, & Richman, 1985). For example, the difference in performance between the verbal and non-verbal components of the intelligence quotient (IQ) was seen as a measure of dyslexia in English speaking countries, though not elsewhere. Dyslexia appears to affect the male population more than the female population though this has some critics (Olson, 2002; Shaywitz, Shaywitz, Fletcher, & Escobar, 1990). Olson (2002) described gender differences being affected by levels of reading deficit and IQ, whereas, Shaywitz et al. (1990) suggested referral was prejudiced. However, there is supporting research to suggest that there is a marked gender difference in dyslexia of the ratio 4.5:1 male to female (Miles, Haslum, & Wheeler, 1998).

In more recent research, dyslexia has been examined to determine the effect of co-occurring conditions such as attention deficit (hyperactivity) disorder (AD(H)D), mathematics difficulties, language difficulties, and motor and visual-motor skills

(Moores, Nicholson, & Fawcett, 2003). In addition, more has been done to see the effect of lexical encoding and phonological awareness, and visual and auditory skills with maturing age (Thomson, 1999).

The majority of researchers hypothesise that memory, and in particular long-term memory, plays a role in supporting phonology in order that phonemes can be compared and contrasted when at the identification stage. This enables the coding of phonemes through auditory, visual and motor sensory mechanisms. Memory enables complex linguistic knowledge to flow fluently between grapheme, phoneme and lexical processing. Dyslexia has been found to interrupt this smooth flow of information causing a more disjointed pathway. This is most evident in the mastery of reading (Ramus, Pidgeon, & Frith, 2003a; Snowling, 1995). Dyslexia is considered a language based processing problem involving phonological decoding at a single word level combined with phonological processing difficulties which hamper letter and sound correspondence learning (Casalis, Dusautoir, Colé, & Ducrot, 2009; Snowling, 1981; Snowling, 1995; Snowling, Goulandris, & Stackhouse, 1994; Vellutino, 1979). It is a condition which extends into adulthood (Ramus et al., 2003b) resulting in continuing phonemic awareness difficulties in part attributed to short-term verbal memory impairment.

A typical profile of dyslexia observed a number of years ago in psycho-educational evaluations, and which helped in diagnosing dyslexia, was the ACID profile. The diagnostic tools used showed that dyslexics had difficulty with arithmetic, coding, information and digit span. There has been, however, a concern that the ACID profile is potentially biased given that some of the subtests are administered under time conditions. If the timing is exceeded through slow processing speed, for example, then a clear picture is not achieved and so caution is advised (Miles, 1983). Difficulties with other cognitive processes such as visual, motor and auditory skills are reported by various researchers (Nicolson & Fawcett, 1990; Stein & Walsh, 1997; Tallal, 1980) as characteristically challenging, too, for dyslexics, though, explanation of these findings is hard in the framework of the phonological theory. Therefore, researchers have sought to find answers elsewhere.

Hence, parallel research has taken place in this on-going investigation of dyslexia. Visual deficiency in dyslexia (Ahissar, 2007; Eden et al., 2003; Vidyasagar & Pammer, 2010) highlighted by poor contrast ability, spatial issues and a poor acuity to motion, led researchers in the direction of investigating the magnocellular pathways (Stein, 2001), while other researchers explored dyslexia at a genetic level to determine where the origin of dyslexia comes from (Finucci, Guthrie, Childs, Abbey, & Childs, 1976). In brief, familial examinations to consider the hereditary incidence of poor reading ability have been conducted (Hallgren, 1950). Hallgren (1950) concluded that dyslexia was an inherited condition after carrying out research on 116 dyslexic individuals. In addition, research looking at twins (DeFries & Fulker, 1985; DeFries, Singer, Foch, & Lewitter, 1978) confirmed the high familial incidence of dyslexia and concluded that it was a complex and heterogeneous condition.

Other gene research has aimed to isolate specific chromosomes responsible for dyslexia (Grigorenko, Wood, Meyer, & Pauls, 2000). There appear to be some corresponding results to suggest that specific chromosomes are identifiably linked with dyslexia (Cardon et al., 1994; Fisher et al., 2002) though the exact location is still in debate.

As a result of gene research observations, hereditary characteristics appear to include an age factor (DeFries, Alarcón, & Olson, 1997) which presents improvement in reading with age contrasting with spelling which declines with age. In addition, an IQ factor is postulated at a genetic level such that age effects are more marked in children with higher a IQ than those with a lower IQ (Knopik et al., 2002).

In considering dyslexia as a learning disorder, dyslexic people find it difficult to acquire literacy skills automatically, where automatisation is viewed as an important ability for language acquisition. Researchers who perceived that automatisation enables fluency, accuracy and speed of language development, particularly for grapheme and phoneme correspondences, saw merit in studying the cerebellum (Nicolson, Fawcett, & Dean, 2001). The cerebellum deficit was advanced to explain that dyslexic individuals find it difficult to integrate resources when presented with a number of competing tasks simultaneously. This difficulty was not evident to the same extent when tasks were presented independently and solely. The overall effect reduced the ability of a dyslexic to concurrently assimilate information without decay in skill, thus interrupting automatic fluency. Nicolson and colleagues (2001) suggested that for a dyslexic to acquire the same level of skill therefore, they would need far more repetition. Further, an element of compensation in skill development was noted which evolved from a need to use whatever resources were available to achieve automatisation of a task (Fawcett, Nicolson, & Dean, 1996; Nicholson & Fawcett, 2005). The role of the cerebellum, automatisation and the link with memory in acquisition skills are discussed later.

Though all the research reported here is relevant to this thesis, other very important research has been carried out recently. Without too much elaboration, researchers have, with modern MRI and PET scan technology, been able to study at a physiological level the mechanisms within the brain that function when learning skills such as reading and spelling. This has led to investigations to determine if there are differences between the functioning parts of the brain in known dyslexic and non-dyslexic individuals when performing similar tasks (Paulesu et al., 1996; Rumsey et al., 1999; Shaywitz et al., 2002). The reader is directed to these papers for further detail. There are interesting observations regarding the right hemisphere of the brain which might be detected in the reading of analogue clocks, which are presented next.

A processing deficiency in dyslexic people is apparent when information is presented to the left visual hemifield. Mini left neglect is “a right-sided spatial bias in selecting and processing visual information” (Hari, Renvall, & Tanskanen, 2001, p.1377). Hari et al. (2001) found that “dyslexic and normal readers differed consistently both in judging the temporal order of visual stimuli presented to the two hemifields and in perceiving a line growing from left to right, or vice versa, in a line motion illusion task” (Hari et al., 2001, p.1377). Though the deficiency is prevalent in the left hemifield, results imply that both visual hemifields are affected, displaying slow attentional capture linked to slowed temporal processing. Though mini left neglect observation tends to be mild, the effect that it has is still unknown and may only be minor. However, a sluggishness to capture visual information toward the left side might contribute towards difficulties with reading which begins from left to right. There is additional support for Hari’s left mini-neglect hypothesis from other researchers (Facoetti & Turatto, 2000) and this helps in providing further reinforcement to the magnocellular deficit hypothesis.

In summary, research into dyslexia has been prolific and the knowledge gained has enabled a greater understanding of the pattern of difficulties of the syndrome. What is clear even from the earliest research is that dyslexic children who have literacy difficulties acquire language skills in a different way to non-dyslexic children. In the same way that the ‘language’ of mathematics is understood better by some children than others, the focus on determining a reason why has been undertaken. The current research aims to provide additional knowledge to hone understanding. The next sections provide additional background to the more established theories to emerge in dyslexia research, namely, the phonological theory, the magnocellular theory and the cerebellar theory.

2.2.1 Phonological Theory

With the phonological theory, the link between grapheme and phoneme correspondence is correlated to the alphabetic system and relates to the speech and sounds generated within words and provides a foundation for the reading of the alphabet. A number of researchers (Baddeley, Gathercole, & Papagno, 1998; Larkin & Snowling, 2008; Snowling, 2008) have found that dyslexics are particularly poor at phonological awareness, which is then considered to be a primary reason for difficulties in reading and spelling. Further, the role of short-term memory (Baddeley, 2000) has been highlighted in slow automatic retrieval of sounds and letters and basic phonology, which leads dyslexic children to struggle with reading and writing.

Ramus et al. (2003a) found from their research that the most noteworthy cognitive challenge that dyslexic individuals presented with was that of poor phonological skill. They also found that dyslexics experienced auditory problems which impacted on phonological skills, and that motor skills impairment in some dyslexics, but not all, were present. Interestingly though, and in contrast to the cerebellar theory, their research found no influence of motor performance either on phonology or on literacy.

It is argued that rapid auditory processing is essential for accuracy in writing and spelling, as the need to distinguish sounds which blend, necessitates swift links with basic phonology (Tallal, Miller, & Fitch, 1993). This rapid naming skill is also connected with time telling, such that vocabulary associated with time requires rapid retrieval in order to answer time questions at speed. On a phonological level, however, failure to successfully carry out the transition between sound and letter blends will lead at an acoustic level to difficulties in choosing letters when writing.

2.2.2 The Magnocellular Theory

Observations showing a difference in the sensitivity to contrasting light between dyslexics and non-dyslexics, were noted by researchers (Kulikowski & Tolhurst, 1973; Lovegrove, Bowling, Badcock, & Blackwood, 1980). From an anatomical level, deficits in the magnocellular and parvocellular pathways (involving both large and small cells respectively in the visual system) have been postulated giving rise to visual impairment potentially causing difficulties in letter and blend recognition in reading. These are two of the three major visual pathways connecting the retina and visual cortex through the LGN (lateral geniculate nucleus); the third pathway is the koniocellular pathway. Researchers have suggested that there is an abnormality between visual spatial attention and binocular vision within the dyslexic profile (Livingstone, Rosen, Drislane, & Galaburda, 1991; Skottun & Skoyles, 2007).

Stein and Walsh (1997), are strong proponents of the magnocellular deficit hypothesis. They highlight the importance of the magnocellular system in controlling eye movement; hence any impairment in this system is likely to lead to difficulties in being able to distinguish small changes in letter formations. They have observed that some children complain of a blurring of letters and, in severe cases, movement of letters and words around the page. The binocular instability of this condition has been found to reduce progress in reading in several separate studies. Indeed, Williams, Molinet, and LeCluyse (1989) provide supporting evidence to demonstrate that dyslexics can confuse neighbouring letters when reading. However, more evidence is beginning to emerge to suggest that the magnocellular deficit has other contenders with regard to an accurate account of dyslexia. While Skotton (2000) reports previous findings that the magnocellular layers within the brain interact with rapid temporal changes in stimulation with the parvocellular layers, which are dedicated to detecting fine shape and colour variation, he remains unconvinced of the role of the magnocellular route in dyslexia.

2.2.3 Cerebellar Theory

Nicholson and Fawcett (1990) postulated the cerebellar theory; that in dyslexics a motor control deficit relating to balance contributed to motor control difficulties in speech articulation and affected the automaticity of retrieval. They theorised that a dysfunction in articulation contributed toward the accurate generation of sound when reading aloud and replicating sounds being heard. This led to inaccurate understanding when writing. Further, they saw that the role of the cerebellum enabled automatisation through continued practice for improvement of skills, such as typing and reading, as grapheme-phoneme correspondences were automatically reinforced. They observed, through experiments in automatisational balance and time estimation (Fawcett et al., 1996), that dyslexics showed a poorer performance in motor tasks. With regard to time estimation, they discovered that dyslexics found the process difficult.

Research by Ivry and Keele (1989) found that the patients in their investigation with severe cerebellar damage showed difficulties with time estimation, which supports the Fawcett research. However, what is difficult to comprehend is that difficulties in time estimation as reported, which amounted to one second tone type discrepancies, could lead to reading difficulties. Perhaps one of the most difficult fine motor skills to acquire is that of speech articulation as the control of muscles in generating sound is very precise. If the cerebellum is responsible for control of physical speech, then any abnormality might cause articulatory difficulties, which would lead to phonological problems (Ivry, Justus, & Middleton, 2001). Indeed, Ivry and colleagues (2001) suggest that cerebellar impairment might interfere with rehearsal of verbalised material, and this appears to be supported by other researchers advocating the importance of the phonological loop (Desmond, Gabrieli, Wagner, Ginier, & Glover, 1997; Silveri, Di Betta, Filippini, Leggio, & Molinari, 1998).

Other researchers (Denckla, 1985; Rudel, 1985) question the validity of cerebellar examination in dyslexics because they have cast doubt on the purity of the dyslexic samples, citing that some level of co-occurrence with attention deficit hyperactivity disorder may well affect the outcome of the testing. The co-occurrence issue was isolated in the account by Fawcett et al. (1996), together with careful matching of dyslexic and control groups in order to get a clearer picture from the cerebellar testing that took place. Other researchers (Kasselimis et al., 2008) who have replicated the type of cerebellar testing that Fawcett et al. (1996) adopted, have found that dyslexic children showed major impairment on cerebellar type tests. This research sought to examine the effect that AD(H)D had within the population of children tested, however, the sample made no reference to the general ability of candidates such that any discrepancy in IQ cannot be validated against the outcome of testing. In the Kasselimis et al. (2008) research, children with dyslexia were found to have a poorer word naming skill, poorer non-word repetition and weaker processing when compared with the AD(H)D and control groups. Further, they asserted that dyslexic children presented with slower articulation speed when compared with normal readers and those with AD(H)D. This result appears to correlate with other researchers (Catts, 1989; Fawcett & Nicolson, 2002). In addition, they concluded that AD(H)D presented no bias towards slower articulation and decided that it was the dyslexic profile that contributed towards articulation difficulties. This contrasts with other researchers (Ramus et al., 2003a) who were not able to identify cerebellar difficulties in their dyslexic sample, suggesting that some level of co-occurrence may have contributed to the outcome of the findings of Nicolson and others. An interesting observation made by Nicolson, Fawcett, and Dean (1995), was that the performance of the older age group of dyslexics was consistently worse than a younger control group on many of the cerebellar tasks; where a similar finding has been reported by other researchers (Miles, 1983; Turner Ellis, 2002).

Fine motor control in handwriting is often impaired in dyslexic individuals thus complex muscle control is difficult to achieve and this is somewhat characteristic of fine motor control of speech, where similar fine and subtle muscle control is essential for clear articulation of sound. Incidents though, of co-occurring dyspraxia might also contribute toward this impairment. Indeed, while the cerebellar deficit hypothesis shows robustness in offering an explanation of problems of literacy acquisition, the aspect of co-occurrence with other difficulties makes it more challenging to observe traits which can be considered specific to dyslexia. Care, therefore, needs to be taken when considering the role of dyslexia specifically on the skill set of individuals.

2.3 Mathematics, Time and Dyslexia

The researchers recounted earlier have contributed toward a clearer understanding of dyslexia such that a picture and pattern of difficulties have begun to emerge. Some researchers have studied children with known mathematics difficulties (MD) (Andersson, 2008, 2010; Burny et al., 2011; Geary, Hamson, & Hoard, 2000; Geary & Hoard, 2005) specifically to determine areas of weakness in mathematics competency amongst that group. What they have found is that children with MD, in some cases, have displayed considerable difficulty with time telling. Geary and Hoard (2005) reported that children with MD showed weakness in procedures, semantic memory and spatial acuity. However, not all these observations are supported by other researchers (Landerl, Bevan, & Butterworth, 2004). Though procedural weaknesses are acknowledged among other researchers, the examination of any spatial deficit remains unclear. The findings of researchers into semantic memory deficits are also supported (Ashcraft, 1992; Geary, 2004; Geary & Hoard, 2005) outlining that retrieval from long-term memory of number facts, vocabulary and procedure are affected in children with mathematics difficulties (Wilson, Revkin, Cohen, Cohen, & Dehaene, 2006).

When considering the telling of time, automatic clock reading is attributed to rapid recognition of important characteristics of the clock face (Burny, Valcke, & Descoete, 2010) to retrieve information and form from long-term memory. Weaknesses in these areas are acknowledged to exist among children with mathematics difficulties only (Geary et al., 2000; Wise et al., 2008), amongst children with reading difficulties only (Geary, 2003; Jordan et al., 2003) and amongst children with co-occuring mathematics and reading difficulties (Geary, 2004). Mathematics difficulties amongst dyslexic children have also been researched (Miles, Haslum, & Wheeler, 2001; Turner Ellis, 2002), however, there has been no research into dyslexia and time telling, which is the purpose of this thesis.

2.3.1 Age of Acquiring Time Telling Skills

Age of acquisition is in some ways governed by the exposure of time telling to children. Though in school, exposure is structured and presented at an age appropriate level, real acquisition, that is, to be able to tell time, differs from one individual to the next. Several studies have presented findings to suggest time telling becomes acquired between the ages of four years and 10 years (Friedman &

Laycock, 1989; Siegler & McGilly, 1989). What has emerged is that there is a difference in age of acquisition between analogue and digital time. It appears that digital time reading is acquired much sooner than analogue time telling in children's time telling career (Friedman & Laycock, 1989). Freidman and Laycock (1989) found that digital time reading was well developed by first grade (seven years of age), which at this age contrasted with the understanding of hours on the analogue clock. They attributed the difference to the fact that digital time reading requires only knowledge of the Arabic number system. In addition, once children are taught that the colon divider enables hours and minutes to be presented in a format, and when mastered, that the meaning of the zeros in the minute columns represents the hour time, then reading of the digital time is a straightforward process. It merely requires children to name the numbers, as the format remains the same. What is clear from the Friedman and Laycock (1989) research is that digital time telling was found to be easier. What is less clear, however, is whether the digital time was understood in such a way it could be transposed with analogue time, particularly with the youngest children.

From my own experience as a dyslexic, I can concur with the findings of these researchers. Analogue time was very much more difficult than digital time to master. It was only when I received a digital watch for my birthday at age 13 that I began to feel confident that I was able to read time. Reading time and understanding what the time was telling me and how to put that skill in to practice was only achieved a number of years later. The advantage at this age for me, however, was that with my first digital watch I could now 'read the time' directly from the face. I used that skill to compare and correlate the time with the analogue equivalent – the clock on the wall of the classroom. This enabled two important developments in my time telling acquisition. Firstly, it gave me the confidence and assurity that I could 'read' analogue time and compare it with what my digital watch said to confirm my understanding. Secondly, and most importantly, in relation to my age, it appeared to others such as my mother and my friends, that I could now read analogue time at speed. I hasten to add that I would glance at my watch in advance to help with decoding if I thought the question imminent. This strategy was successful until I was questioned about elapsed time.

What is apparent is that time telling improves with age in both speed and accuracy for those children without any mathematics difficulty (Burny et al., 2011). This contrasts favourably with the findings of my research which is presented in detail later. However, Burny et al. (2011) and others have found this outcome differs among children with a known mathematical difficulty. They have observed and attributed a performance decline, increased error rates and miscounting, to a lack of retrieval from memory.

Dyslexic children, too, have displayed slower but improving mathematics skill (Turner Ellis, 2002) in some procedural operations, though in some areas such as multiplication fact retrieval, they have been shown to regress with age. This, however, was recognised as a consequence of reduced practice causing a decline in fast retrieval from memory rather than forced errors. Further, the participants of the Turner Ellis (2002) research showed that they possessed the knowledge but were unable to retrieve it at speed.

2.3.2 Time Telling Approaches

Time telling approaches appear to vary amongst children of different ages and skill level, as would be expected. Younger children being presented with hour times adopt different approaches to those who are presented with specific minute times. Depending also on their mastery, researchers agree that children use an array of processes, too (Burny et al., 2011; Friedman & Laycock, 1998).

When considering time telling in incremental terms, analysis of performance against clock times has been generally governed by two complexity levels identified in analogue time (Burny et al., 2011): simple times presented as whole hours and complex times at five minute and one minute intervals. For the purposes of this thesis, it was decided for the clock comparison task to measure performance in three categories: simple, intermediate and complex times. The simple times were described in the same way as other researchers (Burny et al., 2011) while the complex times were split between five minute increments (intermediate) and one minute increments (complex times).

Strategies to evaluate these different time intervals seem consistent according to researchers. It appears that intermediate and complex times attracted both procedural and retrieval strategies. Procedural strategies rely on individuals remembering processes to establish times such as the o’clock anchor point, and sequencing of the clock in a clockwise fashion. Friedman and Laycock (1989) observed children counting from the top of the clock in five minute intervals followed by one minute intervals to the target time. Procedural approaches require grounding using concrete manipulation and memory and provide security of operation when mastered.

The next stage of development is retrieval, where children have mastered the procedural approach and are able to connect times they see on the analogue clock to retrievable vocabulary and syntax stored in their long-term memory.

The use of procedural and retrieval methods mix and match to suit the needs of the child in determining a time related problem. In my experience, however, to shortcut the procedural/retrieval method, a measure of guessing a time is likely to ensue among dyslexic children, particularly if put under time pressure to respond to a question. These observations of weakness in procedural approaches and retrieval shortcomings have also been measured in children with known mathematics difficulties (Andersson, 2008, 2010; Burny et al., 2011; Butterworth, 2005; Jordan & Montani, 1997).

Another observation made by researchers is the comparative ease with which digital time appears to be mastered. It is thought that simple number retrieval enables digital time to be less demanding to learn than analogue time. However, researchers have commented that strategies, as described, are less reliable in children with known mathematical difficulties (Andersson, 2008; Burny et al., 2011).

2.3.3 Children with Mathematics Difficulties

In recent years there has been greater interest shown in understanding mathematics skills in children with known mathematics difficulties (Andersson, 2008, 2010; Butterworth, 2005; Geary & Brown, 1991; Russell & Ginsburg, 1984). A number of researchers have also studied the differences in mathematics cognition in children with reading difficulties and the co-occurring condition of mathematics and reading difficulties combined (Andersson, 2008, 2010). There appear to be differences in performance of these three distinct groups. Mathematics fact retrieval difficulties distinguish children who fall into the mathematics difficulties (MD) domain, and offers a fundamental characteristic. Other difficulties that children with MD present with include the remembering of procedural operations, committing many more errors, and being slow to calculate and understand mathematics where they adopt immature mathematics processes such as use of fingers to calculate. They find multi-digit calculations difficult and have little in the way of number sense (Jordan et al., 2003) and, in the author's experience, prefer to avoid mathematics as much as possible. The findings of Andersson (2010) are supported by other research on word type problems that include both simple one-step and difficult multi-step problems (Fuchs & Fuchs, 2002; Jordan & Hanich, 2000, Jordan et al., 2003). One interesting observation is that MD children find it difficult to approximate in mathematics (Andersson, 2008; Hanich, Jordan, Kaplan, & Dick, 2001; Jordan et al., 2003).

Those children who have reading difficulties only (RD), according to Andersson (2008), appear to present no difficulties in mathematical procedural approaches, implying that they show no sign of a deficiency in memory, error rate with arithmetic problem solving, number fact retrieval, or multi-step problem solving. They do, however, find word type problem solving much more demanding as their reading skills are weaker.

For children with the co-occuring conditions of mathematics difficulties and reading difficulties (MD+RD), mathematics skills are more problematic. As would be anticipated, researchers have found that children with this co-occuring condition display similar difficulties to the MD group, but their difficulties are compounded by their reading problems. Comprehension of mathematics questions is difficult through simply not being able to decipher and understand the vocabulary and language of mathematics. One curious observation, however, was that approximation skills were found to be normal amongst fourth grade children with MD+RD (Russell & Ginsberg, 1984).

One aspect of mathematics which did present important findings with respect to this thesis and MD and MD+RD participants was that both groups presented 'substantial problems with telling time' (Andersson, 2008, p.117). Further, the difficulties presented were in equal measures between analogue and digital times. Given that the time telling task was small, comprising eight questions, a thorough test of time knowledge seems unlikely. Nevertheless, the children were required to say what time it was in words, which clearly stretched their time knowledge vocabulary.

One further observation to be made of the selection criteria in the Andersson (2008) study was that of the children chosen, the control group possessed a higher IQ than those chosen for the MD and MD+RD groups. This could throw into question the validity of the results given that the children with learning difficulties had lower IQs while showing underperformance when compared with the stronger control group. To counter this potential problem, the participants in the present research were chosen on the basis that the dyslexic participants were of a higher intellectual quotient than their control counterparts, thus eliminating the IQ variable as a possible reason for poor performance.

Another concern with the selected participants in the Andersson (2008) research is that there is no mention of other co-occurring conditions such as AD(H)D. Although much effort has been made to select individuals carefully, there are, given the nature and complexity of learning difficulties, likely to be some instances where children have 'slipped through the net'.

2.3.4 Dyscalculia

To encompass the full spectrum of mathematics research relevant to this thesis, mention must be made of dyscalculia. Dyscalculia is a mathematical disorder affecting the ability to perform mathematics. It is a unique condition which is not affected by any reading disorders such as dyslexia, AD(H)D or general intelligence (Wilson & Dehaene, 2007). Most researchers agree that dyscalculia as a learning disability presents problems in remembering arithmetic facts (Geary & Hoard, 2001; Jordan et al., 2003). Some have defined dyscalculia as a deficit in the development of the sense of numbers and a difficulty processing numerically based information presented in regular ways (Dehaene, 1997; Wadlington & Wadlington, 2008). Another problem that exists among dyscalculic children is the inability to follow calculating procedures. They often choose immature methods by which to attack mathematical problems that can result in high error rates and which take a long time to solve. Learning number facts appears to be a good example of an underlying problem presented by dyscalculia and researchers have suggested that difficulties with memory may be a possible cause (Geary et al., 2000; Geary & Hoard, 2001). Equally, semantic memory difficulties might affect co-occurring reading difficulties which in dyscalculics make word type problems difficult to perform. Other co-occurring conditions of working memory difficulties have been associated with dyscalculia. The working memory aspects are discussed in more detail later but the phonological loop described by Baddeley and Hitch (1974) provides a background to the reason for working memory difficulties emerging with word type problems. It is argued that a reduction in the phonological span leads to general academic problems in dyslexia which can be associated with difficulties in mathematics skills.

Koontz and Berch (1996) carried out a study on children with dyscalculia, comparing them with children showing no mathematical difficulties, using a digit and letter span exercise. They found that dyscalculic children present below average scores on both span tasks, suggesting a general working memory difficulty existed. However, it should be noted that the results were taken from children where the general IQ was not controlled. Other researchers, however, (Geary, Hoard, & Hamson, 1999) did not find a difference between their dyscalculic group and control group when testing children on a forward digit span task, though they did find a difference on backward digit span, suggesting greater demand on working memory and the central executive processing function. Latterly, other research sought to find a clearer answer with regard to forward and backward digit span, by testing dyscalculic and control group children in the same way (Temple & Sherwood, 2002). Temple and Sherwood (2002) also performed a word span and Corsi Block test on their participants to gain a fuller understanding of the role that dyscalculia has on memory skills. The Corsi Block test presents cubic blocks which are tapped in a sequence which the observer mimics. The number of blocks presented and tapped increases to a maximum number of 9. The test measures the correct sequencing and the longest sequence achieved. They found that between the groups there was no difference in working memory measures, nor was there any association between arithmetic ability and working memory. Landerl et al. (2004) concluded in their research, studying eight and nine year old children, that the dyslexic group presented general deficits in processing numbers, which included semantic and verbal information, dot counting, writing numbers and reciting them. In contrast, they reported that dyscalculic children without reading disability did not experience difficulties with tasks involving phonological working memory, or accessing verbal information that was non numeric nor language or non-verbal intelligence. Interestingly, Landerl et al. (2004) also reported that children with dyscalculia, with and without comorbid reading difficulties, showed no qualitative difference in their numerical ability when compared with their dyslexic and control groups. This, however, may be due to the dyslexic and control groups showing greater difficulty on the tasks involving verbal and phonological processing, a characteristic which was similar to research by Jordan and Montani (1997).

Von Aster and Shalev (2007) suggest that dyscalculia may be caused by a genetic deficit which results in pathophysiological mechanisms developing differently in this condition thus affecting numerocity. They speculate that different pathophysiological mechanisms cause problems with memory, speech delay and language impairment to cause dyslexia and attention weaknesses. What is clear is that dyscalculia as a condition is very difficult to separate from other co-occuring conditions in some cases and that to suggest that an individual is dyscalculic on the basis of poor retrieval of number facts for instance is problematical. In the same way, it is problematic to suggest dyslexics show dyscalculic tendencies when compelled to retrieve number facts. T.R. Miles (2006), in a personal communique proposed that to separate dyslexia and dyscalculia in such a way as to suggest that the two conditions are independent of one another, is likely to lead to improper diagnosis in the overall analysis of an individual. This researcher has had experience of only one student who showed severe difficulties with mathematics and could be described as presenting a dyscalculic profile. Literacy, reading comprehension and processing were within the norms for the individual's cognitive ability, however, his mathematics skills were extremely weak and after many years of specific, structured and cumulative mathematics support, the individual still found mathematics difficult. To be dyscalculic, an individual would present a severe weakness in most aspects of mathematics conceptualisation such that they cannot appreciate numbers, nor have the "feeling" for the size of numbers when attempting to access mathematics.

2.3.5 Automaticity

If by describing a skill as automatic, it means that the skill is quick to enact, accurate, and successful then it must reach a high level of retrievability from memory, a high incidence of success, resulting in a heightened level of personal confidence. For skills to reach a retrieval level of automaticity, they need to have been rehearsed many numbers of times, whether it be reciting a poem from memory or riding a bike. Automaticity, therefore, is the goal to aim for when developing any new skill.

To appreciate the complex nature of automaticity and the many cumulative processes and skills needed to master a task – consider flying a helicopter. Flying a helicopter requires an understanding of the world around the aircraft where the wind and the weather are the primary influences externally. In addition, the pilot requires good eyesight to see into the distance and to be able to read their instruments clearly. They require knowledge of where they are going, how long it will take and, given that the aircraft may fly low to the ground, any obstacles that might get in the way. Inside, the aircraft is a complex machine, requiring skills in coordinating hands and feet, eyes and balance on a platform which is constantly moving in directions akin to being on a rollercoaster ride. The machine is versatile and able to move in three different directions in one manoeuvre of the flight stick and pedals. The effect on the body, particularly balance, can lead to a sense of feeling sick, of 'losing your stomach', a lot like motion sickness in a car when following winding country lanes at speed. Therefore, to achieve automaticity as a pilot when all these processes become second nature requires practice and very careful instruction. Further, when presented with a situation that challenges the pilot like an unpredictable change in the weather, then to be an expert at flying the aircraft enables thinking resources to be diverted elsewhere in dealing with the challenge. In addition, decisions might need to be made under serious time stress conditions as, for example, with Flight 1549 where Captain Sullenberger, on hitting a flock of birds and having lost power to both engines of his Airbus 320 aircraft, expertly and with incredible skill, with very little time to think, managed to land his plane safely in the Hudson River, New York in January 2009.

In a similar way, though not quite so life threatening, time telling is a skill which requires an array of information to be presented in a way that can be conveyed clearly. For this to be achieved, a level of automaticity needs to be attained. Unlike flying a helicopter, the skill of telling time is known by many more people and, in school, children learning to tell time become aware that they can do so at an early age. Those who find it difficult, however, are left wondering why.

The synopsis offered at the start of this chapter on time telling provides a précis of the skills required in telling time. As analogue time is the most difficult to translate and convey, demands are greatest, and in some circumstances are exacerbated by time constraints in response. Therefore, to consider the mechanism and role of automatisation in this circumstance is essential.

Automatisation may be described as a competence in the principal skill while being unaffected by a concurrent activity or process. Measurements of ability in automatisation are often tested by a dual-task paradigm (Navon & Gopher, 1980; Nicolson & Fawcett, 1990; Yap & Van der Leij, 1994). In the dual-task experiment carried out by Nicolson and Fawcett (1990), and Yap and Van der Leij (1994), motor balance tasks were interrupted with an auditory choice task. For the dyslexic group, their performance was affected by attempting to execute simultaneous tasks. Although attending to an auditory stimulus while balancing are two independent tasks and differentially different exercises, the research outcome suggests that automaticity to function correctly, must encompass control mechanisms to divert energies accordingly. In a similar way, the expertise of the helicopter pilot to divert 'skills', enables the aircraft to be flown. With respect to time telling, a more important aspect of automatisation is that of rapid naming.

When an individual looks at an analogue clock, they are presented with an array of numbers, symbols or simply marks on a round or square clock face. The three hands are likely to be aligned differently to one another and, as such, require to be translated from a positional representation to a description that can be understood. The first stage, therefore, is visual observation. The next is deciphering location and what value each of the hands has in this representation. It is likely that people examine the position of the hands differently; some may look at hours first while others look at minutes first. Either way, this procedure needs to be adopted within a few seconds to be able to be understood and conveyed. For this to happen successfully, rapid retrieval of information is essential.

Rapid naming and retrieval is a known weakness of dyslexia because processing skills are often slower in the dyslexic profile. Rapid automatic naming is a term

used by researchers (Wolf, Bowers, & Biddle, 2000; Wolf et al., 2002) to describe the retrieval from memory of orthographic or phonological information. Skills in both these areas enable a child to recognise words for reading and spelling. Improvements in these skills, researchers have found, improves reading comprehension (Mehta, Foorman, Branum-Martin, & Taylor, 2005). Dyslexia research has shown that there are phonological processing deficits (Rack, Snowling, & Olson, 1992; Snowling 1998). The research has found that in the dyslexic profile, children find it difficult to retrieve phonological representations, found in the form of reading nonsense words, rhyming and nonsense word recognition (Rack et al., 1992). Orthographic knowledge comprises syllable and phonemic awareness through speech and the visual look of words, combining to enable correct spelling to be recognised and repeated. Vellutino (2003) describes orthography as being the visual facilitator and coordinator in aspects of reading. Therefore, in order to master the skill of reading and spelling, an understanding of the respective components of phonology, orthography and visual processes are required to be automatic (Wolf & Katzir-Cohen, 2001). The mechanisms of learning spelling and reading, therefore, closely mimic the skills of time telling insofar as vocabulary understanding, vocabulary repetition and the presentation of the analogue clock representing all this information requires similar automatic processing.
According to Katzir et al. (2006), good comprehension skills are achieved by both rapid retrieval of information via rapid automatic naming, and word recognition efficiency through having strong orthographic recognition skills. At word level this notion is supported by Wolf and Bowers (1999) who hypothesised that spelling recognition is improved as a result of rapid retrieval. Further, slow word recognition is likely to affect reading comprehension due to high demands on working memory (Perfetti, 1991). According to Clark, Hulme, and Snowling (2005), they theorise that through improved automaticity there is improvement in rapid automatic naming which enables readers to read more fluently, thus enabling and improving reading comprehension skills. This contrasts with poor readers whereby, through longer processing times, a more disjointed fluency in reading ensues causing greater resources to be directed towards decoding, thus slowing down reading fluency and hence affecting reading comprehension (Rayner & Pollatsek, 1987). Although this observation has been made in literacy development, little has been reported of similar observations in time acquisition, as conceivably the mechanisms are alike. It is not unreasonable to imagine that time telling becomes more efficient when rapid automatic naming of vocabulary and visual orthography of the clock coincide.

2.3.6 Inhibition

One other area to consider, and which is observed by researchers in relation to the acquisition of language skills, is that of inhibition. Reiter, Tucha, and Lange (2004) observed among dyslexic and non-dyslexic participants in their executive functioning experiments that inhibition was correlated with the level of difficulty a task presented. The outcome was that dyslexic children found inhibition very difficult resulting in a loss of focus. This led the author of this current research to consider the effect of inhibition on the participants of this research, particularly with the younger children taking part in the Time Comparison Task experiment. The questions presented will be the most challenging for the seven year olds because of the three complexity levels prepared for investigation. Therefore, inhibition may well materialise through the young age group guessing more often at answers. An aspect of inhibition also of interest is that of extraneous bodily movement referred to by Turner Ellis, Miles, and Wheeler (2009). This manifests itself as extra vocalisation, fidgeting or the shaking of the leg when, in the case of dyslexics, they feel under pressure to perform.

2.3.7 Developmental Coordination Disorder (DCD)

More has been learned in recent years about Developmental Coordination Disorder, sometimes referred to as dyspraxia, which is defined as a difficulty in organising movement (Barnhart, Davenport, Epps, & Nordquist, 2003) that might correlate with poor articulation. Although a succinct outline is presented here, it is provided simply as background information in support of fine motor skills impairment. DCD might be connected with problems of language acquisition, perception and thought, leading to a general difficulty in sentence construction and syntax when speaking, though some aspects of these problems may be attributed to other co-occurring conditions such as AD(H)D and specific language impairment. DCD children are often observed as being clumsy and find it challenging to ride a bicycle or perform easily any activity requiring motor control skills. Other observations of this difficulty include limited concentration and not being able to complete tasks though there is a substantial overlap with AD(H)D. This brief summary of difficulties relates in some ways to the troubles experienced by dyslexics and so this is where isolating dyslexia from other co-occuring conditions is problematic. The primary difference, however, is that DCD individuals tend to present a much more problematical profile relating to motor type tasks (Pauc, 2005) and this may play a part in the role of fine motor control in eye convergence, which appears to have relevance to cerebellum control (Pauc, 2005).

2.3.8 Rapid Automatic Naming

The scale and diversity of research in dyslexia culminating in theories such as the phonological theory, still find anomalies that throw doubt on specific deficits explaining dyslexia. What is clear is that reading impairment appears to be the result of a number of issues co-existing to make reading and spelling difficult in dyslexics. In some research, auditory processing and rapid auditory processing have been shown to be weak (Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997), whereas other researchers have found no deficit existing. In rapid naming experiments, participants are required to name varieties of things such as objects or numbers or colours as quickly as possible. Researchers have considered that weaknesses in rapid naming are attributed to difficulty with vocabulary access and retrieval from long-term memory of phonological "language" (Wagner & Torgesen, 1987; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993). Many researchers argue that phonological awareness is independent to rapid naming (Wolf & Bowers, 1999), whereas there is compelling evidence to suggest that there are connections between rapid naming and phonological processing (Compton, DeFries, & Olson, 2001). Further, other researchers considering the role of articulation and visual based deficits have excluded their effect on rapid naming, suggesting that a rapid naming deficit is more likely to be caused by slow phonological processing rather than any visual input deficit (Di Filippo et al., 2005). In addition, it can be argued that auditory deficits do not necessarily predict phonological deficits (Mody, Studdert-Kennedy, & Brady, 1997).

Equally, there exists varied critique of the visual aspect of the magnocellular theory. Visual impairment appears present across a whole spectrum of stimuli and not just tapping into the magnocellular system (Skottun, 2000). Therefore the phonological theory cannot clearly explain the sensory and motor disorders in dyslexia, while the magnocellular theory ineffectively explains the absence of sensory motor disorders in dyslexia.

In this thesis, the dyslexic population chosen was selected because of their relatively high IQ, in order to maximise observable differences between the performances of this group when compared with their control counterparts. Further, co-occurrence of other developmental disorders such as specific language impairment and attention deficit hyperactivity disorder were screened for to prevent skewing of results.

2.4 Memory

In recent mathematics research, the correlation between the primary aspects of working memory, namely verbal and visual-spatial memory, has been studied in more detail (Parmentier, Elford, Escera, Andrés, & San Miguel, 2008; Wilson & Swanson, 2001). This research has been undertaken in order to understand the role that memory has in mathematics and to investigate if there is a connection with the findings in other memory research (Jeffries & Everatt, 2004).

Working memory is the first of a two-stage process and is described as a limited capacity store which allows the processing of batches of information amassed when delivered through auditory and visual senses. This memory function assumes a transit role for information to be transferred from working memory to second stage long-term memory (Baddeley, 2003). For this transition to take place smoothly, Baddeley and Hitch (1974) proposed a three-component model of working memory comprising the visuo-spatial sketchpad and the phonological loop serving the central executive. The central executive, being the primary control mechanism, assists in controlling and regulating cognitive processing to enable a task to be achieved successfully. Subsequently, Baddeley (2000) honed his theory and model to include an episodic buffer component suggesting that, in order for the system to function, episodes within the activity are remembered via the phonological loop and the visuo-spatial sketchpad.

The phonological loop is based on sound and language. It comprises a phonological store which holds sound for a brief moment of time before fading away. It is believed that articulation helps to rehearse the sounds to reinforce remembering. Words of differing lengths can, therefore, put greater demands on articulation with additional demands on memory. This is particularly evident when children try to sound out words of many syllables and the decay of the first syllables often happens before the last syllable is read. Teachers frequently need to remind children of the first syllables for the word to be decoded. With dyslexic children, this problem of deciphering multi-syllable words is compounded if the words are nonsense type words of many syllables. This scenario is akin to learning a foreign language. To learn a language one requires vocabulary and memory for understanding. Depending on the presentation of vocabulary and the context of the language being learned, there are greater demands on the phonological loop. It has been observed amongst dyslexic children that mispronunciation of words will often lead to misspelling of the word and the articulation of the word remains difficult even though the child has been corrected. It is almost as if an incorrect imprint of the word has been cast into the mind, making it difficult to 'repair'. In my own experience of learning a foreign language, I have observed that I recognise similar

sounds to English vocabulary and will sometimes make a connection to help remember the words being learned. For instance, when ordering a train ticket to Madrid in Spanish, which is for a no smoking carriage, one might say 'Un billete de tren a Madrid, de no fumadores, por favor', where the 'de no fumadores' part sounds like 'not for mother' when pronounced quickly. Here is an example of potentially bizarre connections that make learning a language difficult. In summarising, the phonological loop should expedite language acquisition through smooth phoneme representations and sequences and, with the support of the articulatory system for rehearsal, help to reinforce the sounds being learned.
The visuo-spatial sketchpad offers the visual equivalent of the phonological loop and appears to be able to hold onto three or four objects at a time. It provides additional foundation in support of the central executive. It is also a representative measure of non-verbal intelligence and has been found to be a skill predominant amongst architects and engineers. The combined mechanisms of the phonological loop and the visuo-spatial sketchpad help in the manipulation of information. It is believed (Baddeley, 2003) that the visuo-spatial sketchpad may play a role in support of semantic knowledge when contemplating the use of an object through its appearance. This is particularly relevant when considering complex machinery and spatial orientation. Logie (1995) argued that the sketchpad requires visual information stored in long-term memory to help with perceptual skills. What is clear is that the visuo-spatial sketchpad provides a role which needs further investigation. In this thesis, a non-verbal test (Raven, 1958) was used to establish the IQ in the participants in the Time Comparison Task experiment. The results provided evidence that dyslexic students with, in some cases, significant deficits in literacy skills, performed highly on the non-verbal test.

Baddeley (2000) expanded the notion of a three-way interaction for working memory between the visuo-spatial sketchpad, phonological loop and central executive (the mechanism which focuses attention and gives precedence to specific activities) to include a fourth component, the episodic buffer. The episodic buffer is believed to be the binding constituent that connects the phonological loop and visuo-spatial sketchpad together in order to consolidate working memory in support of the central executive. Other researchers endorse the episodic buffer element, seeing it as an asset to working memory and providing a means for working memory to function (Baars, 2002; Dehaene & Naccache, 2001).

The central executive is seen by researchers as offering a function of coordination enabling the three processes: visuo-spatial sketchpad, phonological loop and episodic buffer, to assimilate and make judgement of the task presented (Loisy & Roulin, 2003; Smith-Spark & Fisk, 2007). The central executive is the least understood factor amongst working memory research: though there appears to be consensus to suggest that the central executive system provides control over actions, enabling new behaviour and habitual behaviour to adapt; an ability to prioritise stimuli to make appropriate judgement; activation of the long-term memory enabling future learning, and the coordination and control of the phonological loop and visuo- spatial sketchpad (Loisy & Roulin, 2003).

To further investigate working memory to gain a fuller understanding of the structure, recent research has been examining different aspects of memory span connected with dyslexia research. Verbal memory span has been studied extensively as part of investigations into the phonological loop (Fawcett & Nicolson, 2004; Miles, 1993; Smith-Spark & Fisk, 2007). However, the findings are unclear as to the exact reason for verbal memory span difficulties, as researchers have been unable to distinguish whether the difficulties are attributed to working memory or phonological processing difficulties (Gathercole, 1994) such as articulation (McDougall & Donohoe, 2002) or encoding or phoneme representation (Carroll & Snowling, 2004). More recently, researchers (Wolff & Lundberg, 2002) have examined working memory span and are able to report that this involves the synchronised processing of information which is a much more demanding task for dyslexic individuals than non-dyslexics and contrasts markedly from simple memory span tasks which are inactive by nature. This of course leads to a higher demand placed on the central executive to keep the slave systems of the phonological loop and visuo-spatial sketchpad and episodic buffer functioning together. It is akin to the slowing down of a computer when greater demands are placed on its random access memory store by many programs open at once.

Further, research has been carried out on memory span studying, in particular, aspects of the phonological loop (Smith-Spark, Fisk, Fawcett, & Nicolson, 2003) in an attempt to understand phonological processes such as slow articulation rate and phonological representations (Carroll & Snowling, 2004). Other span research studies have been pursued such as reading span (Daneman & Carpenter, 1980) associated with phonological processing and the phonological loop, operation span (Turner & Engle, 1989), computational span (Salthouse & Babcock, 1991) connected with mathematical computation such as mental mathematics, and spatial span (Shah & Miyake, 1996). It has been suggested (Daneman & Merkle, 1996) that computational and reading spans share the same components of working memory. Researchers agree that working memory span equates to being the most demanding for the diversity of simultaneous skill combinations and indeed have found that there is evidence of a working memory deficit (Jeffries & Everatt, 2004; Smith-Spark, Fawcett, Nicolson, & Fisk, 2004).

Visuo-spatial processing has recently been examined through the auspices of working memory difficulties in college undergraduates (Winner et al., 2001) and it appears that visual processing in dyslexics does not impact on working memory. In fact, Winner et al. (2001) suggest that dyslexia may give dyslexics in some cases a visuo-spatial advantage. This is, in part, supported by further research suggesting that dyslexic children were markedly faster with no accuracy-speed trade-off in recognising impossible figures as being impossible (von Károlyi, Winner, Gray, & Sherman, 2003). However, Helland and Asbjønsen (2003) refer to visuo-spatial difficulties presented among children who carried out the same Rey-Osterreith test as the participants in the Winner et al. (2001) study. Helland and Asbjønsen (2003) report that comprehension in language skills among the dyslexic cohort did not relate to visual tasks, though mathematics performance did. This suggests that language comprehension and visuo-spatial skills might affect dyslexics in different ways. It is acknowledged in both these research groups that improvements could have been made in sample size and selection or in isolating groups with comorbid conditions such as AD(H)D. In both cases, the researchers used candidates where the dyslexic group showed a lower IQ when compared with their control group counterparts. This might have skewed the results in a way that presents a more marked difference between the two cohorts.

Certainly research into visual working memory appears be more galvanised in common observations as illustrated by Olson and Datta (2002) who found in their group of dyslexic children deficiencies in visual processing and short-term visual memory. It is clear that working memory difficulties associated with dyslexia span from childhood into adulthood and the evidence from a number of researchers helps in supporting this observation (McLoughlin, Fitzgibbon, & Young, 1994; Smith-Spark & Fisk, 2007).

Nevertheless, it would appear that working memory is not limited wholly to maintaining position in short-term memory. Instead, a central executive impairment in dyslexics is independent of either the phonological loop or the visuo-spatial sketchpad systems. Indeed, task performance may lead to greater complexity within the spatial sub-system, requiring the central executive to work harder at maintaining performance (Kemps, 1999, 2001).

Additionally, these findings support Miles' (1993) observation that dyslexia is a syndrome which may appear differently between one dyslexic and another. Indeed, in Smith-Spark and Fisk's (2007) research, the results present a picture of a central executive deficit being independent of problems with phonological processing.

Nicolson and Fawcett (1990) proposed the Dyslexia Automatisation Deficit (DAD) hypothesis, which considers dyslexic type profiles and the role of the central executive. This hypothesis proposes that dyslexic individuals adopt 'conscious compensation' strategies to help with automatising skills. This enables extra attention to be diverted to the task in hand. Fawcett and Nicholson (1994) focused on four areas of weakness which cause disruption for a dyslexic; these are, complex skills, time-dependent skills – in particular those that require fast processing speed, 'multi-modality' skills and concentration over time. The central executive as the supervisory attention system helps with intentional control, co-ordination and integration of information (Baddeley, 1986). This fits well with the type of skills weaknesses that Nicholson and Fawcett state in their DAD hypothesis. Other researchers (Baddeley, 1986; Pickering & Gathercole, 2004) studying working memory report that in circumstances of increased working memory loading there is a faster decay in memory items. It is suggested that items first in a sequence are more susceptible to decay than subsequent items.

Observations of dyslexic children at the end of a long school day and the comments of parents suggest that the children come home exhausted from their experience at school. This concurs with the DAD hypothesis that predicts that the cognitive and attentional demands placed on the central executive lead to greater fatigue and stress amongst dyslexic youngsters than controls.

What is clear is that working memory problems in dyslexic children continue to manifest themselves into adulthood, even amongst high achieving dyslexic adults. It is also apparent that processing of information and storage within working memory can be problematical (Smith-Spark & Fisk, 2007). Deficits in processing speed and phonology have led some researchers to postulate the double deficit hypothesis which presents a case for deficits over and above phonology existing to compound dyslexic learning (Wolf & Bowers, 1999).

2.4.1 Working Memory and Mathematics

For mathematics understanding, working memory is acknowledged as being an important factor and has been reported as impaired amongst dyslexic children and adults (McLoughlin et al., 1994). Other studies of complex mathematical concepts suggest that working memory properties may be challenged in mental calculation processing (Fürst & Hitch, 2000; Turner Ellis, 2002). This was indeed evident among the dyslexic verses control groups in the Turner Ellis (2002) research. Findings showed that the dyslexic participants were slower and less accurate in response to mathematical stimuli when compared with their age matched control counterparts. The tasks of retrieving number facts, manipulation and processing of questions using mental modalities presented a marked difficulty for the dyslexic group. Some participants remarked that their 'minds were full' particularly as they attempted to respond to new questions. Likewise, Hecht (2002) in a study of working memory function in mathematics found that the selection of a strategy was influenced by working memory, in the same way that Turner Ellis (2002) reported that dyslexic youngsters verbalised approaches to tackling problems as a means of aiding strategy choice. This may well have been their "aide mémoire" to compensate for memory decay of the stimuli.

In addition, Imbo, Duverne, and Lemaire (2007) sought to evaluate working memory resources and how strategy selection and execution was undertaken in mental arithmetic tasks of varying complexity. Participants from a population of undergraduate students rounded two, 2-digit numbers to the nearest whole number and calculated the answer. What emerged was as predicted; problems with no working memory loading were fastest to answer and the lightly loaded working memory tasks were solved more quickly than those which were highly working memory loaded. Further, large differences were found between complex and simple strategies under memory loaded conditions. These results replicate the findings of Hecht (2002) who reported that counting strategies were affected by working memory demands which were not apparent in memory retrieval. This observation of memory retrieval presented as a simple strategy execution process contrasts with a complex strategy and is crucial to the way working memory is used.

In mathematics research, more appears to be at stake as number fact retrieval is vastly more difficult for dyslexics than for non-dyslexics (Turner Ellis, 2002). Researchers believe that when approaches not involving retrieval are adopted, working memory behaves differently between challenging and easy problems (Seyler, Kirk, & Ashcraft, 2003). Further, Imbo et al. (2007) suggest that participants in their research may have opted for simpler strategies in the case of complex problems when working memory demands became greater. This conscious choice mimics the observations of Turner Ellis (2002) where dyslexics seek to solve problems by whatever means are available to them, often resorting to the 'concrete' early learning approaches that they know work, thus giving them a known schema to refer to, and consequently, lifting the demands off working memory to help with other processes.

It seems logical that if there are fewer working memory resources left, then the preferred route is to use simple strategies as often as possible; after all, this is only human nature. By understanding one's own limitations, short-cuts and adaptive strategies are likely to be pursued. This logic provided the background for examining the use of technology to ease memory hungry demands reported later in this thesis. From personal experience, as a dyslexic, there is little doubt that any opportunity to source easier ways of accessing knowledge is pursued. The research of Imbo et al. (2007) does highlight that in complex arithmetic, working memory is used in strategy execution and strategy selection, thus helping to adapt strategies for processing.

One of the purposes of this current research is to observe if there are differences in strategies used for time telling and time management and to discover if, in time management, adults adopt similar strategies to help with their day-to-day organisation. The time telling task studied in this thesis is a simultaneous two-task exercise, that of visual perception of the analogue clock and digital clock presentations, while actively seeking from memory a comparative answer between the two clock times. This sharing of resources is, therefore, likely to put greater demands on working memory for the dyslexic participants. It is hoped, therefore, that from the results, a variety of strategies will become apparent, given that the complexity levels amongst the questions asked could possibly govern the choice of strategy adopted by the participants when answering the questions.

One interesting research finding by a number of researchers suggests that three working memory operations can be identified which would certainly affect the initial learning of time and indeed of mathematics in general. These are 'simultaneous storage and processing, supervision and co-ordination of elements into structures' involved in the executive processing part of memory (Baddeley, 1986, 2000; Miyake et al., 2000). For these structures to be successfully managed, an element of suppression of irrelevant information which could distract learning must take place (Oberauer, 2003). This suppression process could be difficult for dyslexic children to manage, when presented with time telling information, whereby choosing the right pieces of knowledge to retain and order might be difficult.

2.4.2 Long-Term Memory

The role of long-term memory and its effect on the support of working memory has drawn a number of proposals. It is thought that working memory is activated in some way by part of the long-term memory (Cantor & Engle, 1993) and that working memory capacity is equivalent in size to the activated part of long-term memory (Conway & Engle, 1994). If this observation is true, those children with mathematics difficulties may be unable to use their long-term memory to meet processing needs. This could also be attributable to a limited knowledge of mathematics strategies (Keeler & Swanson, 2001) as a result of weaknesses in memory storage. This analogy of long-term memory capacity has gained support from other researchers (Clark & Campbell, 1991) who postulate that automated mathematics banks gained through familiarisation, with additional support of verbal and visual representations in memory, lead to a larger interconnection in long-term memory. Ericsson and Kintsch (1995) proposed that as short-term memory was limited in life span and that long-term memory is slow in retrieval when compared with short-term memory, then there might be an extendable span between the two memory functions. Their argument was that in higher order processes requiring multiple procedures to be carried out such as playing a piano while simultaneously reading music then there must be a 'middle' component to enable all this activity to happen. They postulated that there was an extension to long-term memory which they entitled long-term working memory. This facility is stable in structure and requires attention cues from short-term working memory to access material in long-term memory. They believe that this mechanism enables the short-term working memory constituent to extend long-term memory processes. Given the existence of this intermediary to long-term memory, the grounding it provides enables long-term memory to remain intact while accessibility is achieved through working memory. In this circumstance, any interruption of activity in a demanding task is easily reinstated through retrieval cues becoming reactivated on closure of the interruption. Certainly, when concentrating on a complex activity, if there is interruption, then being able to re-engage as quickly as possible has many advantages. Banai and Ahissar (2010) appear to support the notion of a mechanism to enable multiple processes to be remembered and acted upon while there is a temporal degradation of short-term memory. They suggest that some kind of implicit, contextual anchor is used to bridge waning memory, sufficient for migration to the next stage of a process to happen. Any problem in the anchor point procedure might impede successful cumulative understanding.

Traditionally, research has viewed short-term memory as being limited in capacity which contrasts with the perception of long-term memory which is vast and far less fluid than short-term memory (Atkinson & Shiffrin, 1968; Brown, 1958). Storage in long-term memory was coupled with related items to enable development; access to long-term memory relying on cues to trigger memories to achieve tasks. One problem highlighted with long-term memory is that of new material interfering with the retrieval of older material original to the task. The speed of this retrieval may vary, and researchers (Newell & Simon, 1972) have found it to take between five to ten seconds in some instances to retrieve chunks of live material, particularly if the material is unfamiliar in memory. Therefore, for successful completion of tasks where error free rapid retrieval is to be achieved, a quicker connection to long-term memory is essential and this is where the notion of a long-term memory bridge is considered (Newell & Simon, 1972). When reflecting upon time telling for the children in this research, for access to and from long-term memory, an association between the visual presentation of time and the auditory description needs to be as fluent as possible. There is no doubt that familiarity enables short-term memory to freely access long-term memory for additional support. Indeed, Schneider and Detweiler (1987) suggest that cues are important as a means of effective recall, thus enabling a memory trace to be established for successful task management. There is, however, a suggestion that long-term memory control is much more difficult (Anderson, 1983), thus affecting accurate selection from memory for future processes to be remembered.

In the areas studied by Ericsson and Kintsch (1995), they demonstrate an improvement in working memory capacity to a certain 'type' of information and activity, and that to expand working memory, a means to make long-term memory more accessible is necessary. This involves encoding and retrieval architecture that allows for efficiencies to be made in the process. Thus, retrieval methods can greatly differ between activities depending on the task undertaken. Mental mathematics retrieval requires rapid processing and frequent updating of the calculation. Under these circumstances it does not require extended storage of previous problems of the same type, though methodologies and fact recovery would require memory processes to maintain momentum. Text comprehension in reading, however, is marginally different. Having completed the reading process, any questions asked with regard to the content of material requires that memory is either retrieved directly from short-term memory or provides sufficient cues to enable long-term memory to retrieve material read in the early stages of the comprehension. Therefore, Ericsson and Kintsch (1995) advocate that a process of long-term working memory is adopted and becomes tailored to the specific nature of the comprehension exercise. Therefore, once the comprehension is achieved, the outcome is stored in long-term memory so that, in future, any reference to the nature of the comprehension may be cued and a response given. Further, their proposal for a long-term working memory module appears sensible as working memory can continue to induce information into long-term memory to continually update the knowledge gained in a subject. This is analogous to the automatic updating of computer software on a laptop in order to enhance continual improvement and is often updated without the user knowing that the activity has taken place, thus it is akin to being 'absorbed' into the skill potential of the machine. In the case of the research carried out in this thesis, demands on vocabulary and spatial skills in time telling could be impaired through lack of accurate assimilation by the dyslexic of material presented by the educator. The result of this would be that accurate retrieval is corrupted by poor or inaccurate input.

Under these circumstances, clarity of understanding through clear presentation to children helps in developing strong interconnections between all memory functions. This input method helps in developing reliable access to long-term memory in order for clarity of thought to be achieved. Further, a summary of research has suggested that working memory competence is a dependable measure of a range of cognitive skills such as comprehension in language (Miles, 1983).

2.5 Establishing the Time Comparison Task Questions

This literature search summarises the original thinking behind this research. Knowledge gained of mathematics difficulties among dyslexic children highlighted that processing speed issues and accuracy in procedural approaches, together with weaknesses in retrieval of mathematics facts, made mathematics learning a challenge.

Knowledge gained in time telling and the link with mathematics skill development was also explored. However, there had been no investigation undertaken to establish the performance of dyslexic and non-dyslexic children when asked to compare analogue and digital time as a time comparison task. The dyslexic children were to be carefully matched with non-dyslexic children across three age bands and on intellectual ability in a matched pairs design, to investigate more thoroughly the skill development process in time telling.

In order to pursue a thorough approach, the research questions conceived by other researchers (Nicolson & Fawcett, 2000; Turner Ellis, 2002, for example), supported the nature of the research questions for this current study. These researchers sought to study the performance of dyslexic and non-dyslexic participants, specifically to identify weaknesses between the two groups. It was decided, therefore, to devise a series of similar type research questions specifically aimed at studying the speed and accuracy among dyslexics and non-dyslexics in telling time, to investigate the hypothesis that dyslexia can affect time telling skills. In order to address this, a Time Comparison Task experiment was designed to explore the following research questions:

1. *When performing the operation of accurately recognising clock times will dyslexics be less accurate than non-dyslexics?*
2. *Will younger dyslexics be less accurate than older dyslexics?*
3. *When performing the operation of recognising clock times at speed will dyslexics need more time than non-dyslexics to answer questions accurately?*
4. *Will younger dyslexics be slower than older dyslexics in their response time?*

These questions were devised to encompass a clear and measurable examination of the performance differences between two carefully selected groups of children and enabled the development of an experiment to statistically measure this operation.

Unit 2 Dyslexia and Time Management in Adults

2.6 Introduction

This unit of the literature review considers adult time management in the context of proficient approaches adopted by adults in their day-to-day personal organisation. The associated link with dyslexia type difficulties is proposed and the literature relating to time management and dyslexia is surveyed.

2.6.1 Time Telling in Adults

There is a paucity of research in adult dyslexia in relation to time and time management which became apparent when the author searched the available research literature. Given that much of the research on dyslexia has studied children's language acquisition, little is still known of the effect that dyslexia has on adult life. It appears though, that this is changing and more adults are seeking to learn about the nature of their own difficulties.

To gain a clearer understanding of the weaknesses presented by dyslexic adults, Vinegrad (1994) devised a 20 point "Adult Dyslexia Checklist Test" which was completed by over 600 adults aged between 18 and 68 years in equal gender proportion. Students enrolled on degree courses comprised the majority of respondents (57%), where 21% were non-students, 15% were A-level students and 7% were enrolled on certificate courses. Some students taking part had been assessed as dyslexic and therefore a comparison was achieved between dyslexic and non-dyslexic participants. The checklist highlighted challenges for the dyslexics primarily in writing, such as writing cheques and spelling. Remembering sequences of numbers, calendar dates and times proved problematic and, in mathematics, participants recorded trouble with memory for multiplication number facts. Though the nature of the questions asked in this thesis questionnaire was inclined toward time management, other questions similar to the Vinegrad checklist were devised to evaluate participant responses.

It was decided to examine dyslexic adult time telling and time management as an extension of the time comparison task, for two main reasons. Firstly, research into adult time telling and time management is rare. It would be a unique opportunity to gain an understanding of adults' experiences, and having learned time as a child, what observations of learning to tell time they might have. Secondly, the research sought to gain anecdotal evidence from participants to understand what it is like to time manage when experiencing dyslexia.

Testimony gained from this part of the research would enable the author to establish if time telling remained difficult for dyslexic adults, to develop a clearer understanding of time management techniques adopted, to find out what technology might be used to assist in day-to-day time management, and to examine if any coping strategies such as routine or avoidance were adopted. The dyslexic type difficulties experienced in childhood are likely to remain in adulthood and so to research and learn more from these experiences might enable improvements to be made in school and the workplace.

Time management (TM) is defined as "the self-controlled attempt to use time in a subjectively efficient way to achieve outcomes" (Koch & Kleinmann, 2002, p. 201). This definition implies that people have the opportunity to decide how they divide up and organise their time. Over a number of years from time management research, what is apparent is that people manage their time in different ways to suit their needs (Macan, Shahani, Dipboye, & Phillips, 1990). Managing time is very personal, with at one end lists being written by people or goals being set to achieve tasks; while at the other end none of these practices are followed.

The aim of this research was to study dyslexic behaviour with regard to time telling and time management, and to establish if the primary signs of dyslexia encroach on the processes adopted in time telling and management. To consider this, an understanding of time management processes is presented. The research into time management offers a number of key facets which enable time management to operate, but at the same time seeks to understand which aspects seem to be predominantly used.

When compiling this literature review, the author was mindful to present a structural theme for the reader to follow. Accordingly, this section refers to the benefit of goal setting as a pro forma of behaviour to establish the successful approach for effective time management by adults. The factors which encroach and influence the success of goal setting as an approach are then presented for comparison. Other elements connected with dyslexia and contributing to the effect on performance in time management are presented later.

2.6.2 Goal Setting

When evaluating time and time management as a process, one aspect deemed to provide structure and success through establishing an approach is called goal setting. Goals appear to be an important process which has been examined by a number of researchers (Hinsz, 1995; Locke & Latham, 1990). There have been two types of goal setting studied; that of the individual assigning personal goals, and goals assigned by someone else. The success of goal setting relies on a number of additional variables which are personal to individuals. Researchers have found (Hinsz, 1995; Strickland & Galimba, 2001) that individuals set goals which they feel confident in achieving and that the benefit of doing so appears to reduce stress levels which poor organisation may create. Goal setting as a motivational tool has been discussed by Locke and Latham (1990). They have found that it influences performance through directing attention and provides a motivational component, which helps to increase effort and persistence. They refer to two goal setting attributes, that of content and intensity (Locke & Latham, 1990). They describe goal content as features of the goal itself such as specifics and difficulty, whereas goal intensity describes how it is accomplished. What has been discovered is that setting specific and difficult goals can lead to improved function through implementation of greater effort and planning, which is in contrast to vague or general goals.

Interestingly, when goals are imposed they can be perceived to be difficult to attain and this leads to frustration as an emotion rather than the feeling of success in accomplishment of a goal (Locke, 1988). Goal setting provides the added benefit that task switching happens less (Strickland & Galimba, 2001). In addition, goal setting appears to affect planning of tasks and strategies adopted in achieving the task. In principle, therefore, setting a goal appears to improve performance through reduction in task switching and improved planning and control. However, Strickland and Galimba (2001) revealed that participants in their experiment who did not set goals and switched between tasks were able to outperform those who had carried out careful planning. Therefore, the assumption that improved planning leads to improvement in performance appears to be open to question. To explain this particular observation, these researchers thought that perhaps it was the nature of the experiment that caused this outcome and, in the real world situation; this result may not be so prevalent. The questionnaire designed for the adult part of this thesis, therefore, presented open-ended questions which enabled participants to explain their experiences in time management so that aspects of practices such as goal setting could be reported. Other researchers (Deci, 1975; Erez, Gopher, & Arzi, 1990) referred to intrinsic motivation as an observation of improved performance through setting personal goals; that is the motivation which comes from inside an individual through enjoyment of the task to drive the task on, rather than external influences. Intriguingly, what emerges from the research on intrinsic motivation is that it has greatest effect when there are no external influences. This applies more when there is a reduction in cognitive interference which is individual. Erez et al. (1990) made an interesting observation that intrinsic value of goals reduced with monetary rewards, suggesting that personal motivation is not simply driven by monetary rewards, but encompasses a number of other factors which require further investigation.

According to Mitchell and Silver (1990), people who set their own goals tend to be more committed and much more motivated, with the result that if any difficulties arise, causing delay, then individuals appear to be able to cope much more effectively. Coping and emotional stress related to any demanding task, can affect self-efficacy such that goal success may become taxing (Gist & Mitchell, 1992). This self-efficacy observation was noted in research carried out on dyslexics' self-esteem by Turner Ellis (2008) and provided evidence that dyslexic women in high-powered jobs found it difficult to present their skills in the workplace if signs of their dyslexia emerged. Under these circumstances, the roles that dyslexic adults take in work might be influenced by motivational skills and their feeling of being able to achieve their role at work.

2.6.3 Cognitive Interference

Cognitive interference is a term coined by Sarason, Sarason, Hayes, and Shearin (1986) to describe distractions such as intrusive thoughts that cause individuals to change direction off task. This disruption was seen as a primary influence in time management that could be controlled with the adoption of goal organisation. Cognitive interference appears to account for the likely behaviour of individuals who show signs of attention deficit hyperactivity disorder which, with co-occurring dyslexia, could present a profile of task switching through the impact of sudden thought and external influences. Presented with a group of independent tasks, lack of prioritising could, under circumstances, lead to widespread disorganisation in the dyslexic and, as organisational skills have been found to be weak in the dyslexic profile, this is likely to lead to poor time management, particularly if goals are not set. A number of researchers have made observations that individuals who are assigned goals or assign goals, are more likely to develop strategies in achieving the task over those who do not (Gist, Bavetta, & Stevens, 1990; Terborg, 1976). Further, as the focus is placed firmly on the goal, cognitive interference is reduced which may be attributed to goals providing a structured environment for better planning. This may help individuals limit the effect that cognitive interference has in enabling re-engagement with the task after the interference has subsided.

2.6.4 Perception of Time

As greater demands are placed upon individuals in the workplace in terms of work intensity and time pressures, then observations of time management have progressed beyond goal setting and priorities to considering mechanics of time management and the nature of systematic working. These strategic components of time management enable an individual to control their perception of time. Macan (1994) found that controlling time was helped by goal-setting and prioritising which led to job satisfaction in some cases, whereas lack of control of time led to tensions, both physical and mental, related to the task. Other researchers, (Adams & Jex, 1999; Davis, 2000; Jex & Elacqua, 1999) found that goal setting and prioritising only partially helped the perceived control of time. Some researchers (Adams & Jex, 1999) found aspects such as the mechanics of time management (e.g., use of notepads and post-it notes) negatively connected with the perceived control of time, whereas time control performance within organisations was perceived as positively connected. It is acknowledged though, that further research is required in this area to establish a clearer understanding (Claessens, Van Eerde, Rutte, & Roe, 2004). What can be drawn from this research is that there is a link between careful planning, performance and stress in the control of time in the work place.

According to a number of models presented by Macan (1994), planning behaviour has a positive correlation with the control of time, which presents a positive correlation to job satisfaction, job performance and reduces stress levels. In a later model, Macan (1994) suggests that the perceived control of time is affected by workload in a negative way. However, in a positive way, job autonomy and planning behaviour helps to achieve control, thus resulting in the same output, reducing stress, improving job satisfaction and improving job performance. In relation to this, a number of questions were prepared in the adult questionnaire reported in this thesis to consider job roles and career paths of dyslexic participants. Further questions were asked relating to organisation and control in order to establish if there were signs of difficulty in these areas. The research presented here (Macan, 1994) with regard to job satisfaction and goal setting seems to show that within a population of working adults, issues in the control of time have emerged. In asking questions with regard to career paths, the present research sought to verify the findings of Taylor and Walter (2003) which looked at occupational choice by dyslexic adults. Taylor and Walter (2003) found the career path of adult dyslexic participants tended to incline toward people-orientated professions such as nursing or sales, rather than professional occupations such as computing, science, finance, or management. They put a possible reason for this trend down to the latter involving more writing involvement and greater time pressure constraints.

The questions asked in the current research would help to determine whether dyslexia had a direct role, and whether or not dyslexics preferred to be autonomous in their job function, thus enabling them to set their own goals at a pace and in a way that best suited them. Moreover, and in connection with this theme, Claessens et al. (2004) observed that the perception of the control of time does have a correlation between workload, job autonomy and planning, such that the feeling of success is achieved. They give a good example of general practitioners who achieve job satisfaction and a high level of workload only so long as they feel that they are able to cope. Claessens et al. (2004) refer to an over-estimation of time in job performance worth further investigation, which relates to a number of the questions in the adult questionnaire within this thesis. This is considered in further detail in the next section.

2.6.5 Planning Fallacy

An area of research which is relevant to the adult questionnaire is that of planning fallacy. This is defined as the tendency to have a misguided opinion of the success of a task being completed in a planned timeframe, when knowing, from past experience of similar sorts of tasks, that the timeframe is unrealistic (Kahneman, Slovic, & Tversky, 1982; Kahneman & Tversky, 1979). Buehler, Griffin, and Peetz (2010a) present planning fallacy as people's optimism in achieving a goal based on careful planning, that they know cannot be maintained, when considering historical factors. A number of sizable projects have been known to overrun and exceed the budget even though initial estimates may have been based on similar projects.

Beuhler et al. (2010a) refer to planning fallacy as connecting with over-estimation and under-estimation of projects which are planned for by all sorts of organisations. In their paper they make mention of projects being 250% over budget and 50% over time as almost a normal expectation in modern planning. A good deal of the research referred to in their paper talks of planning fallacy with, in many cases, students being the primary source of information. These students have been quizzed to determine just how successful their planning and execution of tasks has been. Given that a student population generally has participants who are likely to be of higher intellectual ability, the choice and nature of the types of examination where students have a number of projects to be completed, seems to present a reasonable picture of activity. This then gives a robust set of results to gain better understanding of planning fallacy. There is, however, no mention of the students who took part having any kind of learning difficulty, which may impact upon the results of the analysis. When considering dyslexic students, observations made by researchers (Compton et al., 2001; Wagner & Torgesen, 1987; Wagner et al., 1993; Wolf & Bowers, 1999) show that individuals take longer to process information as a result of their cognitive skills. This might, therefore, lead to a dyslexic student benefitting from additional time when it comes to examinations. From personal experience, another factor needs to be taken into account which is the quality of time spent on a task as opposed to the quantity of time spent on a task. In many cases it is the completion of a task which is taken as the mark of success more than the length of time to achieve it. Planning fallacy, therefore, is one which affects individuals on a personal basis more than on a group basis and is, under these circumstances, easier to observe (Beuhler et al., 2010a).

What is clear is that planning fallacy affects not only students, but also any individual working towards a deadline and attempting to estimate the time needed to achieve the task. It appears that people prefer to view time in the past in a more favourable way, thus causing them to underestimate task completion, and research appears to support this robust characteristic (Beuhler et al., 2010a).

It is apparent that some level of goal setting in the form of deadlines helps to guide individuals as to the length of time they have available, but this differs when deadlines are imposed by others compared with self-setting deadlines (Ariely & Wertenbroch, 2002). Buehler and Griffin (2003) refer to observations made of Canadian and Japanese students in predicting task completion. The researchers found a level of optimism in completion time which differed from historical summaries of the same task. This optimism meant that a task prediction window for completion was estimated for two days before the task due date, though in reality the task amongst most of the students was completed only a half day ahead of the due date. This supports the findings of Flyvbjerg, Holm, and Buhl (2005), who studied why it was that capital projects were often over budget and over time when there was sufficient historical information to guide the planners in achieving a more accurate timescale and budget. Therefore, time estimating and time management without cost is always difficult to attain.

An interesting observation of other researchers (Roy & Christenfeld, 2008; Roy, Christenfeld, & McKenzie, 2005) appears to show that tasks that were short attracted overestimation traits as opposed to longer tasks that were underestimated. These researchers though, saw this as a result of a floor effect observed in very short tasks.

For the purposes of the adult questionnaire in this research, the author was interested in personal experiences of time management and time estimation, which, through the use of open-ended questions, would provide anecdotal evidence of “inside” rather than “outside” influences on planning fallacy (Kahneman, et al.,1982;

Kahneman & Tversky, 1979). When considering the term “inside analysis” this refers to individuals, perhaps within groups, looking internally for guidance in planning, whereas “outside analysis” refers to looking externally to the group, thus potentially taking advantage of information from other sources when making a decision on estimation. Usually an “inside” perspective looks at singular evidence which might lead to task completion in longer or shorter timeframes, whereas the “outside” or exterior view considers the relationship between tasks that have been performed before (Kahneman, et al., 1982; Kahneman & Tversky, 1979). The open-ended questions in this research may provide a forum for other observations made by the dyslexic participants such as, for example, remarks made about personal time estimation, or learning from the practices of others, that they may then apply in their own circumstances. Certainly, planning fallacy tends to present an optimistic opinion of the completion of a task and judging by various researches (Buehler, Peetz, & Griffin, 2010b; Kahneman, et al., 1982; Kahneman & Tversky, 1979), there are more “inside” rather than “outside” processes adopted. The relevance of a past project is not always seen in the light of the current project and so looking “outside” is not considered an option. Further, whether the task be of a practical or non-practical nature the same principles appear to apply.

2.6.6 Motivation

An extension to the “inside” and “outside” model has been developed to encompass additional investigative facets which are associated with motivation (Buehler et al., 2010a; Newby-Clarke, Ross, Buehler, Koehler, & Griffin, 2000). Motivation is seen as a primary factor, through greater incentive, to achieve goals and thus affect planning fallacy. Other factors that appear to support motivation include temporal planning, imagery, status, and social pressure in the form of group over individual effect, and social power (Buehler et al., 2010a). For example, when a task is to be performed in the short-term, the temporal effect is heightened (it must be finished now), whereas in tasks taking place much further in the future, the temporal effect is diminished. The “inside” view of planning fallacy appears to help with enabling specificity and contributes towards motivation. It has less effect when considering the “outside” view of planning fallacy where “outside” influences need to be remembered to support decisions in task procedures, thus affecting the predictive time for task completion. It appears that prediction is often optimistic in circumstances where individuals are more motivated (Buehler, Griffin, & MacDonald 1997). In the case of the present research it will be interesting, where it is known that dyslexic individuals have difficulties with memory and time practices, to see what effects on motivation, temporal perspectives and memory are reported. It might be that as tasks become closer to deadlines, the comments made by dyslexic participants might present a markedly less optimistic or confident level of achievement compared with the non-dyslexic participants (Eyal, Liberman, Trope, & Walther, 2004).

One further consideration is that of people's comments regarding obstacles in the way of planning predictions. When given a number of tasks to be concurrently tackled, for example, do other "thoughts" get in the way thereby causing the predicted timing of a task to become eroded. Though the questions asked in the questionnaire did not directly enquire about planning on specific tasks, other researchers (Buehler et al., 2010a; Sanna, Parks, Chang, & Carter, 2005) have found that when tasks have been made to be hypothetical, then this affects the temporal loading on individuals' planning, which is noticeable when compared with real tasks.

It appears that with hypothetical tasks, predictions seem to be more optimistic regarding task completion when the task is closer in predictive time. This contrasts with real tasks where individuals show less optimism when the task is closer in time. This causes a change in focus to look for reasons why the task may be delayed in completion. Interestingly, other researchers (Sanna et al., 2005; Shepperd, Ouellette, & Fernandez, 1996) have found that when faced with a task starting imminently, people tend to predict earlier completion time if encouraged to focus on plans rather than obstacles to completion. This differs if the task is to be started in a couple of months' time as the predicted completion time is not affected because planning is more thorough. In addition, if given a task to do within a timeframe, if the timeframe is presented in a positive way such that there is plenty of time to complete, then attitudes toward it differ when compared with a negative approach, where the comment may be that there are only a short number of weeks to complete. This equates to the "but" compared with the "and" motivational scenario. Using the word "and" is much more motivational than using the word "but" which tends to be negative. In fact, Sanna et al. (2005) report that with a positive timeframe participants behaved more favourably whereas, with the negative time-limiting reservation, participants perceived the deadline to be very much closer, which affected their forecasting of task completion.

Another aspect for improvement in predicting task completion is that of reduced disruption. Beuhler et al. (2010a) coined the term "closed and open tasks" (p.49) to help explain the different influences placed on time prediction. A closed task is one which is relatively insular whereby the task is not disturbed by outside disruption. An open task is comprised of multiple steps which can involve different locations and different times for the combination of processes to be completed.

Open tasks will tend to require several work sessions to complete and so are susceptible to interruption and delay once started, even though the intent to complete is high. A good example is one of painting a room, where once the materials are gathered together, the task appears to be a relatively short one to complete. However, other factors and interruptions encroach, causing completion of the task to be extended over a longer period of actual time. In the present thesis, any anecdotal evidence with reference to planning and estimation by the dyslexic group will help to provide evidence of this type of planning fallacy. This researcher anticipates that difficulties with long-term and short-term planning for dyslexics will be reported. Beuhler et al. (2010a) make the interesting observation that an open task which is started early will not necessarily be completed early, as the delay influences tend to extend the deadline to the prediction. It will be interesting to see if dyslexic participants in this research refer to "inside-outside" conditions that affect their planning control. Further, the open-ended nature of questioning might provide an insight into the methods used to estimate the tasks to be completed. As has been reported, planning fallacy is a major factor when considering the prediction of task estimation, which affects individuals and groups in different ways. It is this researcher's prediction that planning fallacy is likely to be more prevalent in the dyslexic group as a result of potential weaknesses in temporal processing, memory and organisational skill impairment.

2.6.7 Time Discounting

A decision of priority between competing tasks is often made on the basis of several factors, whether for personal or professional reasons. The benefit of performing one task ahead of another is considered and in some cases urgency is paramount in decision making. Time discounting is the "science" of controlling the priority of task completion and is often defined as "urgency rules over importance" (Covey, 1989). In a scenario where an individual has two tasks from which to choose, and both tasks are to be completed, individuals consider the benefit of task "a" over task "b" if there is a temporal constraint on one or the other. If the individual has the freedom of choice and the first task is unimportant but urgent, it is likely to receive attention first as opposed to the non-urgent task. The need to complete the urgent task causes a discounting of time of the second task because the second task lies far in the future.

In the current research, anecdotal evidence is sought to determine if there are signs of time discounting, as it is purported that greater time discounting presents a sign of fewer time management (TM) techniques (Koch & Kleinmann, 2002). It is anticipated that those techniques which are mechanical such as "note taking" or "to do lists" are quickly abandoned. These kinds of activity are time consuming in the short-term and require writing. Consequently, it is predicted that the dyslexic participants will report that mechanical time management techniques are avoided and that priority over choice of topics is based on urgency. As a result, time management techniques may not be adopted as often. However, the use of technology to help to substitute mechanical methods may become evident. Further, it is anticipated that influences such as interruptions and tight deadlines, will present characteristic difficulties for dyslexics.

A number of researchers (Fischer, 2001; Koch & Kleinmann, 2002) refer to observations they made where individuals, deciding on use of their time, adopt a discounted utility of options. Utility is a measure of the gain or benefit in a project over the cost of achieving that benefit. When the utility is discounted, it means influential considerations made of the gain are offset against the cost. For example, it has been observed that procrastination may affect decision making (Koch & Kleinmann, 2002). Thus, tasks some way in the future might become neglected as the deadline is so far away. When the deadline approaches, further time discounting may still occur as other tasks become priorities. However, as task deadlines become more and more imminent, an increase in stress levels and anxiety occurs (Jex & Elacqua, 1999). For the dyslexic participants it may become apparent from their answers in the questionnaire that signs of anxiety are prevalent and talk of avoidance strategies emerge, particularly if task timing becomes more difficult. The difficulty in controlling time discounting habits may well contribute toward poor time management, especially in task estimation, thus making future planning of similar tasks difficult, as referred to in the planning fallacy section earlier.

2.6.8 Rational Choice Theory

In time management understanding, a number of researchers (Boudon, 2003; Herrnstein, 1990) have made reference to rational choice theory as a means of making clearer judgement in the decision making of task choice. Rational choice theory aims to explain the mechanisms involved in maximising the utility for task completion against cost. It is personal and one individual may make different choices from another, given the circumstances in which they find themselves (Herrnstein, 1990). It does appear, however, that imminent events seem to gain prevalence over events in the distant future and researchers have noticed a tendency towards impulsive type behaviour as a governing factor in choice. This behaviour might explain the idiom – "act in haste, repent at leisure" (derived from a quote by William Congreve, 1695). Indeed, Newby-Clark et al. (2000) have sought, through experimentation, to determine the outcome of optimistic and pessimistic scenarios to determine inherent behaviour for task choice and have shown that there are instances where impulsive choices are made, when time constraints are tight. The findings of rational choice theory and time discounting appear to show that the further in the future a task is for completion, impulsive behaviour diminishes. Herrnstein (1990) refers to a different theoretical consideration to that of rational choice, which is hyperbolic time discounting, which better fits the profile of time discounting as it is more fluid and adjusts according to the length of time a task is performed. In hyperbolic discounting, small delay periods toward task completion reward cause the value of the discounting to fall very rapidly, whereas longer delay periods toward reward, cause discounting to fall more slowly (Mazur, 1987).

What is apparent is that rational choice is influenced by a number of factors which are considered appropriate at the time of choice. This is a little like choosing the best case scenario for returning a well hit tennis lob from an opponent, where the choice of return stroke is based on one’s personal perception of a successful return, when taking into account all available information. Herrnstein (1990), in summarising that rational choice theory is personal also suggests that it can be affected when groups of individuals are required to make a rational choice. Therefore, considerations by individuals within the group are more likely to be affected. In this thesis, individuals may make reference to group influences.

In terms of the effect of rational choice theory on time discounting, Koch and Kleinmann (2002) have found that with tasks where success is obtained later in a timeframe, the gain is considered less in preference to the gain made by an immediate task. They refer also to the greater effectiveness of an hyperbolic discounting paradigm in preference to rational choice theory. They argue that people utilise the discounted approach such that the utility of gain is greatest when it is closer in time to the gain of other tasks much further in the future. This type of inherent behaviour might explain the reason why people wait until a fast approaching deadline before applying more effort to complete. Further, Koch and Kleinmann (2002) suggest that difficult projects with long lead times might often become difficult to start as people’s time discounting perception leads them to avoid the task in preference to other tasks which are more immediate and which do not necessarily require the same level of effort. An additional observation made is that if completion times for goals are underestimated, then it has the effect of motivating individuals to complete, even with unrealistic assessments. The effect is that less discounting results in high utility, hence the desire to work towards the goal in question (Francis-Smythe & Robertson, 1999; Newby-Clark et al., 2000).

Other factors influencing the effect of discounting can include the attractiveness of a task to complete as it has added value. What is implied by time discounting in time management processes is that there are a number of perceptions made by individuals in making choices and hence this makes time discounting much more personal, with factors such as impulsivity having an impact on an individual basis (Kirby, Petry, & Bickel, 1999).

2.6.9 Emotional Factors

Other researchers presenting personal differences in time discounting scenarios also refer to age factors. Young people often discount future outcomes more steeply than older individuals (Green, Fry, & Myerson, 1994; Trueman & Hartley, 1996) because the less steep the discounted value of an outcome the more it extends into the future and young people prefer immediate value. Additional factors that impact on time discounting decision making include emotion (Gray, 1999), stress (Jex & Elacqua, 1999), uncertainty (Mischell & Grusec, 1967) and routine (Rachlin, 1995). All these issues were considered investigating in this thesis as a means of developing a profile in dyslexic time management. With regard to self-esteem emotions, it is well documented that dyslexic individuals experience challenges (Riddick, Sterling, Farmer, & Morgan, 1999) and in time management, emotion has a major effect. Positive emotional conditions influence longer delay in gratification, and negative emotional factors are likely to affect the time management process (Yates, Lippett, & Yates, 1981). With stress, researchers in time management have found evidence that students discount much more steeply when stressed compared to those who are not (Gray, 1999). Often this experience will lead individuals, certainly under time pressure conditions, to make poorer decisions (Ordóñez & Benson, 1997). It is this kind of scenario that leads dyslexics to feel most uncomfortable (Miles, 2006; Miles & Varma, 1995). Koch and Kleinmann (2002) propose that time management is influenced by the uncertainty of an event leading to heightened levels of stress. This is mediated, though, through developing routines. Researchers have found that discounting becomes less steep the more an established routine is achieved (Rachlin, 1995). Consequently, it is predicted in this thesis that dyslexics prefer routine as it enables a structure to their day, thus relieving stress.

Given that a number of time management processes have been discussed, in a global sense, and that little research exists studying time management and dyslexia, it is hoped that the findings of this thesis will enable a greater understanding of the role of time telling in the effectiveness of personal time management practices. To gain a more comprehensive picture of time management away from individuals' observations, the researcher was interested in examining remarks made by dyslexics of other people's time management skills, to ascertain if characteristic approaches were evident.

Kirby et al. (2008) have studied learning strategies and approaches with dyslexic students at university to determine the way they engage with high level learning. An interesting finding has been that dyslexics appear to show a greater use of time management and study aids in their learning and thus are able to develop deep learning approaches. The research was carried out using self-assessment type tools and though the findings seem positive in the way time management appears to help, what is not clear are the types of time management approaches adopted. Nevertheless, what is acknowledged is that given the opportunity that these students have with additional guidance from the learning support units at the universities, they can overcome some of their dyslexic difficulties, such as with working memory, slow reading and comprehension, to enable them to access the curriculum. Interestingly, whereas the researchers expected the dyslexic participants to show a much more shallow approach to learning, with the help of the study aids, this was not the case. Consequently in this present thesis, questions are asked regarding the use of technology in helping to manage time, in order to gain an understanding of the level and nature of the support it might provide. Despite the use of the self-reporting questionnaire employed by Kirby et al. (2008), there is uncertainty as to the type of study aids used, though in their conclusion the researchers summarise that dyslexics appear to report learning strategies and study approaches which are different from other students carrying out their evaluation.

2.6.10 Dyslexia and Self-esteem

In recent years, more research has been undertaken on dyslexia and self-esteem, both in young people and adults. The process of integration and support within the classroom of children with dyslexia has required that a fuller understanding of dyslexia and its effects on motivation and achievement are considered (Rose, 2009). Self-esteem and self-efficacy are important characteristics of an individual's strengths. A number of researchers (Miles & Varma, 1995) have highlighted the negative effects of self-esteem if children feel that they are unable to function with the rest of the class. Children will often actively avoid their difficulties. A model presented by Humphrey (2002) illustrates the functional parts of an individual in support of self-esteem. Entitled "The Self" (Humphrey, 2002, p.29), the model presents two components that aid effective self-esteem. The first component is "self-concept" which is described as a memory based schema that uses episodic and semantic memory to help individuals recall information relevant to themselves. Given that dyslexics struggle with memory type issues, then the negative impact of poor retrieval is likely to be significant. The second component is "the ideal self" which is an individual's view of themselves that enables them to function with confidence. So, the role of self-esteem is viewed on an individual basis, given unique characteristics, and thereby is a process which differs from one individual to another. Given the demands of various learning challenges for the dyslexic, the complex and difficult nature of time telling tasks may result in lowered self-esteem, especially if confidence in the processes involved is weak. The impact made by peers, teachers, parents and others on a dyslexic child's self-esteem has been studied by Glazzard (2010) but there appears to be a scarcity of research in this field. Glazzard (2010) observes a number of emotional experiences that dyslexic children have and cites examples of youngsters feeling stupid or disappointed and, in extreme cases, having a sense of isolation from the work being carried out in class. These experiences reinforce the influence of parents in being able to support their youngsters in the best way they can. It appears that children's self-esteem can change when they realise that they have been diagnosed with dyslexia and they can better understand their own cognitive profile.

The influences of school, of course, can extend into adulthood, such that feelings of isolation and not being able to do tasks, for example, which are literacy based, present greater problems for the individual. Moreover, this accentuates their feeling as an adult (Burden, 2008). However, the self-esteem of adults with dyslexia is less researched, though it appears that self-esteem issues continue into adulthood based on the experiences an adult has as a child. It is argued that the type of school, in accepting and supporting dyslexia, can make an important contribution to limiting self-esteem issues (Nalavany, Carawan, & Brown, 2011). It was considered important, therefore, to explore the issue of self-esteem in responses to questions posed in the adult questionnaire prepared in this research. A number of the participants taking part in this thesis questionnaire had attended dyslexia-friendly schools. They had received support for their difficulties in literacy, and also confidence and self-esteem. It was of interest, therefore, to see if any of their experiences as adults reflected their childhood learning.

2.7 Establishing Research Questions for the Adult Questionnaire

The second unit of the literature review considered research in time management relevant to everyday life. It is only in recent years that time management has been studied amongst dyslexic adults. This latter research has looked at university students to establish time management practices as a component of study skills strategies.

The scarcity of literature relating to TM and dyslexic adults gave rise to this current research. The literature review considered the subject and drew on processes and principles which the author felt influenced the likely approaches linked with dyslexic type difficulties.

To gain an appreciation of dyslexia and its effect on TM, it was decided to develop a questionnaire. The questions chosen would examine time and time telling in childhood followed by TM practices and observations later as adults. The longitudinal structure of the questionnaire enabled the researcher to establish if mathematics and time telling proved difficult in childhood for these adults. The aim, also, was to ascertain any links with time management reported in adulthood. A checklist of difficulties (Vinegrad, 1994) helped to establish that writing, spelling and temporal markers were common problems amongst a sample of dyslexic adults. Thus, to appreciate the "physical" nature of dyslexia on a day-to-day basis with TM practices was felt relevant.

To achieve this, literature relating to time management was examined and is reported. Matters relating to planning fallacy, time discounting, rational choice theory, time estimation, cognitive interference, motivation and goal setting were appraised to illustrate the anticipated difficulties adult dyslexics are likely to experience in managing their time. Also, the importance of the control of time, time predictions and planning behaviour, guided the reader toward a clearer understanding of the general framework of time management leading to successful task completion. Finally, the literature review considered decision making in career choice, routines at work, and technology used to assist TM in the lives of dyslexic adults.

From the literature review, a number of questions relating to TM were formulated to establish a clearer understanding of the role which dyslexia might have, and to help explore the hypothesis that dyslexia affects personal TM. The research questions are as follows:

1. *Will the dyslexic participants refer to greater difficulty with mathematics than the non-dyslexic participants?*
2. *Will dyslexics show greater concern for time and aspects of time?*
3. *Will dyslexics find personal time management difficult, compared with non-dyslexics?*
4. *Will dyslexics embrace technology as a means of coping with their time management skills?*
5. *Do dyslexic participants report finding overestimating and underestimating time a challenge when compared with the non-dyslexic group?*
6. *Will reading timetables by the dyslexic group prove more difficult for them than the non-dyslexic group?*
7. *Will dyslexia influence career choice and lifestyle changes?*

The common thread running throughout this research concerns temporal issues relating to time telling and time related planning. The author could not find any other research which examined time management approaches in dyslexic adults who were not students.

Unit 1 and Unit 2 of the literature review are associated with Section 1 and Section 2 of the research experiments. Section 1 presents the Time Comparison Task experiment undertaken in Chapter 3, and Section 2 presents the Adult Time Management experiment undertaken in Chapter 5.

Chapter 3 Section 1 Time Comparison

3.0 Introduction

Cognitive skills associated with time telling and dyslexia are discussed next to provide a framework for the presentation of Section 1 which includes the methodology and results for the time comparison task. Consideration is made to encompass the areas of time and the learning of time which are likely to be impacted upon by dyslexia.

This chapter is presented in four parts:
3.1: The Theoretical Attention to Time
3.2: The Methodology
3.3: The Accuracy Results
3.4: The Reaction Time Results

3.1 Theories of Attention to Time

We assume that time telling is quite a straightforward skill, but it is actually quite a complex process especially in analogue format. The analogue clock offers a precise and informative array of intricate information which is only clear when the clock is understood. However, to achieve a thorough grounding there is a requirement in understanding time vocabulary, to develop visual perceptual understanding, memory (Geary, 1993; Geary et al., 2000), vocabulary, articulation (Hitch & McAuley, 1991), rapid naming (Wolf et al., 2002) and automatisation (Nicolson & Fawcett, 1990). These all contribute to time telling developmental skills (Friedman & Laycock, 1989; Nicolson & Fawcett, 1990). Further, learning delay and deficits attributed to dyslexia (Brown & Loosemore, 1994; Done & Miles, 1988; Snowling, Goulandris, Bowlby, & Howell, 1986) may present in the overall findings of the experiment.

3.1.1 Development and Acquisition of Temporal Concepts and Skills

There are three distinct components of clock knowledge (Friedman & Laycock, 1989). First, there is the ability to look at a clock and read the time. Secondly, there is the ability to operate on clock times to extract relationships. In the same way as arithmetic operations are important key components to the understanding of number, so the ability to determine what the time will be in 30 minutes or how long it is until 4 o'clock are essential parts of understanding the clock system. Thirdly, there is the understanding of the meanings of times, such as knowing "where" a given clock time falls within a day or what activities typically occur at that time.

Telling time using both the analogue clock and the digital clock, presents differing challenges for children learning to tell the time. In many respects, time telling using the analogue clock is similar to simple arithmetic, as connections need to be made between the alignment of the clock hands and the names used to describe the alignment in words. Once understood, it is followed by a counting procedure such as 08:22 (Friedman & Laycock, 1989; Siegler & McGilly, 1989). Similarly, telling digital clock time (e.g., 20:55) is quite akin to decoding one and two digit numbers. On a digital clock, however, the maximum number needed for recognition and recall in terms of number names is fifty-nine (Friedman & Laycock, 1989). Consequently, basic arithmetic skills that are vital for successful time telling also represent well documented core deficits (i.e., fact retrieval and counting procedures) in children with MD (Andersson, 2008).

Children when telling time use procedural and accompanying retrieval strategies in a similar way to other mathematics learning approaches (Burny et al., 2009, 2011). Older children, however, tend to depend more on retrieval strategies than younger children (Case et al., 1986; Friedman & Laycock, 1989; Siegler & McGilly, 1989). According to Friedman and Laycock (1989), time telling requires the observation of the hands and in particular the hour hand and where it points closest to, on the numerals of the clock face. Next to consider is the minute hand, in the same way counting clockwise to the point where the hand rests in five minute marks followed by one minute increments as necessary.

Knowledge of how to tell time is built up over an extended period; it involves both procedural and declarative facts stored in long-term memory; and the direction of change is from greater use of backup strategies to greater use of retrieval. Unlike other mathematical domains, time telling is a highly perceptual task requiring a great deal of visual information processing.

Siegler and McGilly (1989) found that in 14% of trials, children started at the hour and counted by fives until they read the five minute mark to which the minute hand pointed, or until they found the five minute mark immediately before the minute hand, from which point they continued to count by ones until they reached the minute hand. The strategy of counting by ones from the hour hand to reach the minute hand position was less favoured. Twenty-six per cent favoured counting forward using a five minute mark rather than the hour. They would say the number of minutes past the hour as indicated from their starting position and counting on by ones, fives or a combination of both until they reached the minute hand. A small percentage of children (6%) adopted the strategy of counting backwards from the five minute mark that was past the position of the minute hand, decreasing by ones.

Further, it was found that children started from a variety of places around the clock. The two most prominent landmarks were the hour and the half hour, which constituted 32% of the responses for the hour and 17% for the half hour in the trials performed. Almost three quarters (73%) used at least three strategies on at least three trials. This variable strategy use is consistent with the distribution of associations model (Siegler & Shrager, 1984) where, depending on the confidence criterion and the specific answer retrieved, any available strategy may be used on any item. It is consistent with the general hypothesis that when children have moderate amounts of experience with particular items on a task then they tend to use multiple strategies (Siegler, 1988).

Further investigations revealed that solution times were quickest and most accurate with the use of retrieval strategies. Moreover, solution times using the strategy of counting from an earlier five minute mark or a later five minute mark were significantly faster than when counting in fives or fives and ones from the hour. It was found, however, that the retrieval method was a least accurate strategy with one minute times. Further, longer solution times for a problem governed which backup strategy to use and that backup strategies required more time to execute, thus causing longer solution times (Siegler & McGilly, 1989).

When considering the types of errors made by children during the trials, there were three primary types: misreading the hours, hour hand/minute hand reversals, and being off by one minute.

One other error that emerged was that of rounding. Children seemed to round times that were within one minute of a five minute mark to that five minute mark. This rounding process increased the number of errors on these problems. In addition, this process increased the use of retrieval rather than backup strategies. Thus, children seemed to be mis-encoding the one minute time as the nearby five minute time.

In relation to the current research, points of interest were considered individually. When performing the operation of accurately recognising clock times in the Time Comparison Task experiment the following two research questions are investigated:

1. *When performing the operation of accurately recognising clock times will dyslexics be less accurate than non-dyslexics?*
2. *Will younger dyslexics be less accurate than older dyslexics?*

When performing the operation of recognising clock times at speed in the Time Comparison Task experiment; the following two research questions are investigated:

3. *When performing the operation of recognising clock times at speed will dyslexics need more time than non-dyslexics to answer questions accurately?*
4. *Will younger dyslexics be slower than older dyslexics in their response time?*

3.2 Time Comparison Task Methodology

The Time Comparison Task is designed to measure a difference in performance between dyslexic and non-dyslexic participants when answering comparative questions on time, presented on the computer. The aims of the experiment are to determine if any difference emerges in accuracy and reaction time speed of performance between the two groups across three age bands - seven years, 11 years and 14 years.

The dependent variables are temporal ratio data such as time taken to respond to the clock time questions and categorical nominal data on the accuracy, or otherwise, of participant answers.

The independent variables are the three age bands: Key Stage1 (KS1) - seven year olds, Key Stage 2 (KS2) - 11 year olds and Key Stage 3 (KS3) - 14 year olds; and the Group: Dyslexics, and Non-dyslexics. It should be noted that through this section of the thesis the term “control” is used and describes the non-dyslexic group.

3.2.1 Group

The nature of this experiment was to determine if dyslexia relates to a difference in performance in reaction time speed and accuracy for participants telling time. To measure this, it was necessary to experiment with two groups of participants, those who were dyslexic and those who were non-dyslexic (controls). They were matched on chronological age and on intellectual ability (IQ).

A spelling test was chosen rather than a reading test because it is widely regarded that children can have dyslexic type problems and still be adequate readers (Miles et al., 1998). As spelling is often the most difficult to remediate for a dyslexic participant and as a large pool of subjects came from schools specialising in teaching literacy to dyslexics, it was felt that measuring spelling ability would be a more accurate measure of dyslexic type difficulties.

In order to minimise variables that could affect the results, the following were controlled for: age, gender, geographical location and socio-economic status. The age of participants is detailed in section 3.2.1.2. Gender is controlled for by selecting female to male participants in the ratio 1:4 (Miles et al., 1998).

All participants were chosen from 14 private schools, where three of which accepted only dyslexics and the remainder had an established dyslexia unit. It was decided that these schools were sufficiently alike in socio-economic status and methods of teaching to justify the research selection criteria. Moreover, in the case of the dyslexic participants, their poor spelling performance could not be due to a lack of opportunity to learn (see Appendix A.1, A.2, A.3, A.4, A.5, and A.6).

The controls were from the same geographical locations (rural Southern England including schools in Somerset, Wiltshire, Berkshire and Hertfordshire) (see Appendix A.9 for further details).

3.2.1.1 Participant Selection

Over 350 children were initially screened after parents gave active consent for their children to take part. From these, 120 students were chosen to take part in the research experiment. These 120 students were sub-divided into three age bands (seven, 11 and 14 year olds) such that there were 40 participants in each age band; of those, 20 were dyslexic and 20 were control. Section 3.2.2 outlines the tests used for initial selection and section 3.2.3 presents the criteria for dyslexic and control choice.

3.2.1.2 Age Band

Table 3 presents the chronological age range of the three age bands used in the experiment.

Table 3: Age Range

Age Band	Age (years and months)
Key Stage 1 (KS1) 7 years	7 – 7:11
Key Stage 2 (KS2) 11 years	11 – 11:11
Key Stage 3 (KS3) 14 years	14 – 14:11

The three age bands factor, namely: seven, 11 and 14 year olds, will be referred to throughout this thesis as Age. Each age band represents the Key Stage level achievement made in the understanding of time. Each Key Stage introduces time vocabulary and time presentation, and is designed to develop children's skills in telling time, in elapsed time principles, related time activities and the organisation of information (see Key Stage requirements 3.3.1). This study represents and compares cognitive understanding of time concepts over a seven year period; however, it is not a longitudinal study.

3.2.2 Initial Screening Tests

The initial screening tests, presented next, were administered to all potential participants for this research.

The Schonell S1 Spelling Test (Schonell and Schonell, 1952)

This spelling test was chosen to measure the spelling ability of all candidates. It was a simple test to administer to large groups of people and was appropriate for students aged from seven to 15 years. The number of words spelled correctly helped in the decision making for which group (dyslexic or control) to assign participants to and was the first of a triad of tests in the selection procedure.

The Raven Standard Progressive Matrices (SPM) (Raven, 1958)

The Raven Standard Progressive Matrices test (1958) was the second test in the selection procedure. As a non-verbal intelligence quotient (IQ) assessment it enabled an understanding of the reasoning ability of the candidates. Dyslexic candidates were chosen to be of higher reasoning ability than their matched control counterparts. This was to establish that lower intellectual ability would not be a contributory factor in a difference in performance in the research experiment for the dyslexic participants when compared with the control participants. The Raven Coloured Matrices (Raven, 1962) was used for candidates aged 7 years. Standardised scores were used to match participants across the groups.

The Bangor Dyslexia Test (BDT) (Miles, 1982, 1997)

The Bangor Dyslexia Test was the third test administered to candidates. As a well-established assessment tool for signs of dyslexia, it was easy to administer on an individual basis and it gave an accurate evaluation of dyslexic attributes. The test’s author is renowned in the field of dyslexia research and the test has scientific credence.

The control participants were assessed in the same way to establish that they showed no typical dyslexic pattern of responses. Further, the researcher liaised with the school to ascertain any cases that had a previous diagnosis of dyslexia.

Overall, candidates were checked to confirm that there were no dyslexic participants included in the control group or, conversely, no control participants in the dyslexic group.

The participants were identified as being dyslexic or not, but they were not measured for any mathematics difficulties. The Bangor Dyslexia Test (BDT), however, presents mathematics questions relating to subtraction and multiplication which do cause difficulties for dyslexic students. These include memory demanding exercises involving fact manipulation and retrieval.

Analysis was carried out on the mathematics components of the BDT (subtraction and multiplication) to determine any signs of mathematics difficulty (MD), though these components are used in the BDT framework as a measure of working memory and are therefore not specific in determining an explicit mathematics difficulty (MD). Chi-square analysis (reported later) was performed for both groups across the three age bands (see 3.2.4.2 Bangor Dyslexia Test).

3.2.3 Criteria for Choosing Participants

The selection of candidates was made using the following criteria:

Participants were excluded if they had any of the following:

(1) problems of adjustment, such as attention deficit disorder (ADD) or attention deficit hyperactivity disorder (AD(H)D). Each school was given a diagnosis questionnaire for teacher evaluation of potential participants (see Appendix A.7). Potential candidates were eliminated if they presented over 80% scores in the "Often" (3) or "Always" (4) categories or any subjects scoring 3 or 4 with time telling, punctuality and time management. Further, any candidate diagnosed formally with ADD/ADHD was eliminated because these syndromes can be co-occurring with dyslexia.
(2) a result below the 25th percentile on the Raven Standard Progressive Matrices (Raven, 1958) or on the Raven Coloured Matrices (Raven, 1962). This equates to an intelligence quotient score (IQ) of at least 90 as a standard score. This was to safeguard that no participants were included who had low reasoning capacity.
(3) any gross physical handicap; because this could have been a more significant factor than dyslexia for under-performance.

To qualify for the dyslexic group a participant needed:

(1) a Schonell spelling age score (Schonell & Schonell, 1952) of not less than 18 months below mental age, or 24 months below chronological age for those participants in the 14 year old age group; this level is at least one standard deviation below normal expectation. It should be noted that in the case of seven year olds the spelling age criteria was relaxed as spelling performance at this age is often closer to or ahead of chronological age due to the test content presenting c-v-c words in the early stages. This is demonstrated by some seven year old dyslexic participants who show high non-verbal reasoning scores, presenting spelling ability scores ahead of their chronological age. In addition, the seven year old control participants with high IQs demonstrated a more marked spelling ability, suggesting that intelligence might contribute to improved spelling performance. This intelligence influence is less pronounced in spelling age for the older dyslexic participants because the spelling content is much more demanding as the test progresses. The dyslexic participants therefore presented higher IQ scores at the same level or higher than the control participants.

(2) at least 4.5 positive indicators out of 10 on the Bangor Dyslexia Test (Miles, 1982, 1997). Evaluation of the Bangor Dyslexia Test has shown that a total of more than 4 positive indicators offer discrimination of dyslexic from control participants.

To qualify for the control group a participant needed:

(1) a spelling age equal to or above mental age or within 6 months of it, or in the case of children in the 14 year old band, a spelling age of at least 12 years, to ensure that there were no conflicting signs of poor performance attributable to any possible contaminating conditions.
(2) not more than 3.5 positive indicators out of 10 on the Bangor Dyslexia Test.

It was decided in the early development phase of the experiment that in order to acquire a thorough profile of time telling skills among this age group that females should be included in the experiment. A gender ratio of 1:4 female to male was chosen to reflect the recognised gender ratio discovered between dyslexics (Miles et al., 1998).

Table 3.1 summarises the mean initial test scores for the selected participants presented by Group and Age.

Table 3.1: Mean Initial Test Scores for Group and Age

Group	Type	Age					
		7 years		11 years		14 years	
		Age or Matrices Score	Standard deviation	Age or Matrices Score	Standard deviation	Age or Matrices Score	Standard deviation
Dyslexic	CA	7.5	+/-3.54	11.5	+/-3.08	14.5	+/-3.72
	SA	7.1	+/-8.26	8.98	+/-5.56	9.8	+/-18.07
	MS	121	+/-8.71	116	+/-7.06	110	+/-7.26
	BDT	6	+/-1.37	7	+/-1.48	7	+/-1.14
Control	CA	7.3	+/-3.86	11.41	+/-3.31	14:3	+/-3.39
	SA	9.2	+/-13.8	12.08	+/-7.27	13.8	+/-6.44
	MS	116	+/-8.18	113	+/-7.88	109	+/-8.63
	BDT	2	+/-0.97	2	+/-0.96	2	+/- 0.81

Note:

CA = chronological age (years and months). Standard deviation is given in months.

SA = spelling age (years and months). Standard deviation is given in months.

MS = performance on Raven Standard Progressive Matrices or Raven Coloured Matrices.

BDT = Bangor Dyslexia Test.

3.2.4 Matching Participants

Initially a series of analyses were performed to establish that the group were well matched for non-verbal intelligence quotient assessment (Raven Matrices, 1958) and mental age[1]. In addition, participants' scores on the Bangor Dyslexia Test (Miles, 1982, 1997) were contrasted for participants in the control versus dyslexic group to establish that the two groups were heterogeneous. A two-way between-subject analysis of variance was conducted for the three dependent measures; non-verbal intelligence quotient assessment (Raven, 1962), mental age and the Bangor Dyslexia Test (BDT). The between participant factor was Group (control versus dyslexic).

3.2.4.1 Non-verbal IQ assessment (Raven)

There was a marginal main effect for Group with control participants (mean = 113.0; Standard Error = 1.36) scoring less well than dyslexic participants (mean = 115.7; SE = 1.45), $F(1,116) = 4.00$, p=.048. The objective of this matching procedure was to establish that their Raven's IQ did not differ between the two groups. The fact that they do so, marginally, is not considered a serious problem as

[1] Binet and Simon (1916). The development of intelligence in children: The Binet–Simon Scale. Publications of the Training School at Vineland New Jersey Department of Research No. 11. E. S. Kite (Trans.). Baltimore: Williams and Wilkins.

the higher IQ is observed in the dyslexic group. As such, it may be argued that subsequent analyses that may demonstrate performance deficits in the dyslexics cannot be attributed to their Raven's IQ.

There was no main effect for Gender, $F(1,116) = .676$, $p=.413$, nor was there an interaction between Group by Gender, $F(1,116) = 1.49$, $p=.230$.

3.2.4.2 Bangor Dyslexia Test (BDT)

As anticipated, there was a significant main effect of Group, control (mean = 2.03; SE = 0.157) versus dyslexic (mean = 6.48; SE = 0.157) for the BDT between the two groups, $F(1,118) = 405.1$, $p=.001$.

Further analysis of the Bangor Dyslexia Test (BDT) (Miles, 1982, 1997) was carried out on the two mathematical component subtests of the test, that of mental subtraction and multiplication number fact retrieval (see Table 3.2 and Table 3.3). Both subtests rely on individuals mentally manipulating mathematical information. The marking of the subtests fall into three distinct indicator categories of dyslexia: no indicator (-), half indicator (0) and a positive indicator (+).

The Bangor Dyslexia Test was administered to all participants across the three age bands to validate selection. In all three age bands, there was a significant difference between the dyslexic and control cohort. When considering the sub-tests in detail, the subtraction task comprises six orally presented subtraction problems. These questions range in difficulty from simple single digit subtraction, to more complex subtraction problems, some of which cross the ten-barrier. The participant offers a response as quickly and as accurately as possible, and the examiner records the result. Several measures are considered by the examiner when the answers are given. Where a participant answers the question incorrectly, a score is recorded. Other scores are recorded if participants hesitate on response, or they repeat the question, or ask for it to be repeated, or if the participant uses fingers to answer the question. All observations of this nature are recorded and analysed in accordance with the answer pro-forma devised for the test. The age of the child is also taken into account as part of the marking process. When the questions in the Bangor Dyslexia Test were devised they were tested most thoroughly to establish a benchmark to indicate signs of dyslexia.

Table 3.2: Subtraction Sub-test of BDT for Age by Group

Subtraction Cross-tabulation			7 Years			11 Years			14 Years		
			–	0	+	–	0	+	–	0	+
Chi Condition	Control	Count	6	9	5	18	2	0	14	6	0
		Expected Count	3	8	9	10.5	4	5.5	7	4	9
	Dyslexic	Count	0	7	13	3	6	11	0	2	18
		Expected Count	3	8	9	10.5	4	5.5	7	4	9
Total		Count	6	16	18	21	8	11	14	8	18
		Expected Count	6	16	18	21	8	11	14	8	18
Chi-square Test			Value	df	Sig	Value	df	Sig	Value	df	Sig
Pearson Chi-square			9.806	2	.007	23.7	2	.001	34.0	2	.001

As this subtraction subtest relies on mentally manipulating a variety of questions without the use of any concrete aids such as fingers or paper it indicates mental performance rather than mathematical understanding, though without mathematical understanding the task is a difficult one.

The time tables subtest requires participants to recite times tables in full with a preamble; for example, when reciting the four times table, participants would say: “one times four is four”, and then carry on to complete the four times table. Depending on the age of the child, different multiplication tables are asked. For the seven year old participants, the four times table only was asked. For the 11 and 14 year old children, they were required to recite the six, seven and eight times tables. Observations were made of the oral responses, such as the participant losing their place, providing the wrong answer, hesitating with answers or repeating or asking for guidance. Use of strategies such as fingers for counting was noted. All these observations were examined against the scoring guide to determine signs of dyslexia.

Table 3.3: Times Table Sub-test of BDT for Age by Group

Times Table Cross-tabulation			7 Years			11 Years			14 Years		
			–	0	+	–	0	+	–	0	+
Chi Condition	Control	Count	6	3	11	10	6	4	15	5	0
		Expected Count	3.5	3	13.5	5.0	5.5	9.5	9.5	7.5	3
	Dyslexic	Count	1	3	16	0	5	15	4	10	6
		Expected Count	3.5	3	13.5	5.0	5.5	9.5	9.5	7.5	3
Total		Count	7	6	27	10	11	19	19	15	6
		Expected Count	7	6	27	10	11	19	19	15	6
Chi-square Test			Value	df	Sig	Value	df	Sig	Value	df	Sig
Pearson Chi-square			4.5	2	.106	16.5	2	.001	14.0	2	.001

Overall, it can be seen (in Table 3.2 and Table 3.3) that across the 11 and 14 year old age bands there is a significant difference between the dyslexic and control cohorts. However, there is a non-significant finding among the seven year old age group on the times table subtest. These findings would suggest that the dyslexic participants, overall, did find the subtests difficult. It is also known that subtraction and multiplication number facts are weak in the dyslexic profile (Turner Ellis, 2002), though this is more as a result of memory type difficulties for retrieval than mathematical understanding per se.

The mathematics subtests of the BDT rely heavily on working memory, which is a known issue for dyslexics. It is the *observations* made by the assessor in evaluating the responses to the mathematics subtest questions which determines signs of dyslexia or mathematical difficulties. Given the scientific rigour of the Bangor Dyslexia Test as a measure of signs of dyslexia as opposed to mathematical difficulties, and the experience of the researcher in recognising dyslexia, it was felt that through the use of this test, and in combination with spelling and intellectual ability that dyslexic candidates tested for this research were dyslexic.

3.3 Materials and Apparatus

3.3.1 The National Numeracy Strategy (1999)

Table 3.4 summarises the ages of children in the Key Stages of The National Numeracy Strategy. It helps to provide a guide to the time related topics described later in this chapter.

Table 3.4: The National Numeracy Strategy (1999)

Age	Stage	Year	Tests
3-4 4-5	Foundation		
5-6 6-7	Key Stage 1	Year 1 Year 2	National tests and tests in English and mathematics
7-8 8-9 9-10 10-11	Key Stage 2	Year 3 Year 4 Year 5 Year 6	National tests and tests in English, mathematics, and science
11-12 12-13 13-14	Key Stage 3	Year 7 Year 8 Year 9	National tests in English, mathematics, and science
14-15 15-16	Key Stage 4	Year 10 Year 11	Some children take GCSEs Most children take GCSEs, GNVQs or other national qualifications

Those participants who took part from English schools used The National Numeracy Strategy (1999) as set out by the then Department of Education and Employment. This curriculum was used for guidance to establish the expectations that could be placed on students at Key Stage One, Two and Three in learning time. One school that took part comprised an American population who were taught the same topics in accordance with their curriculum. For the purpose of the experiment, little appreciable difference was found between the curricula.

Described below are the teaching goals and expected outcomes for learning *Time* for each of the Key Stages and the *Time* curriculum for the American participants of the same age.

National Curriculum (National Numeracy Strategy 1999, p. 2-5)

Key Stage 1: Year 1 (5–6 years old)

A student is expected to:

- Name the days of the week, hour, read the time to the hour or half hour, day, week, and month.
- Use a sand timer to measure what can be done in the time before it runs out.
- Know basic elapsed time “what will the clock show in one hour’s time.”
- Know the seasons of the year, morning, afternoon, evening, night, midnight.
- Know terminology such as weekend, today, yesterday, tomorrow, now, soon, early, late, before, after, and first.

Key Stage 1: Year 2 (6–7 years old)

A student is expected to:

- Use vocabulary from the previous year and for that to be extended to include names of the months and terms such as fortnight.
- Understand hours in a day, minutes and seconds, minutes in an hour and how many seconds in a minute.
- Understand days of the week.
- They should know in order the months and seasons of the year.
- They should know significant times in the day or year, for example their bedtime and their birthday, which includes the day and month.
- They are expected to read the time to the half or quarter hour on a digital clock or an analogue clock and be able to identify quarter to the hour or 15 minutes to the hour.
- Estimate the least and most time, to carry out an activity.
- Suggest the most suitable unit of time, for different activities, such as walking, or sleeping.
- Demonstrate what takes about 10 seconds, 1 minute, and 1 hour

Key Stage 2: Year 3 (7–8 years old)

Students are expected to:

- Remember the vocabulary of the previous year and to extend the vocabulary to include century, calendar, date, am and pm.
- They are also taught the number of days in a year and their date of birth.
- Read the time to five minutes on a digital and analogue clock and to recognise 8:35 as 35 minutes past 8 or 25 minutes to 9.

Key Stage 2: Year 4 (8–9 years old)

Students are expected to:

- Name the days of the week, months and seasons, vocabulary such as a fortnight, morning, afternoon, evening, noon, today, yesterday, tomorrow, and the weekend.
- Know new vocabulary such as millennium.
- Be introduced to rhymes such as “30 days hath September, April, June and November. All the rest have 31, except for February which has 28 days or 29 days in a leap year” (Good, Gregory, & Bosworth, 1813).
- Demonstrate some knowledge of elapsed time, to include: how long ago, how long will it be, arrival and departure times.

Students in this age group are also expected to:

- Identify the time to the minute on a 12 hour digital clock and analogue clock. They should know for example that 4:37, equates to 37 minutes past four, or 23 minutes to five as an equivalent.
- Read timetables such as bus or train. The layout is taught with a simple tabular format. They are expected to fill in blanks on such a timetable based on departure times or elapsed time to travel.

Key Stage 2: Year 5 (9-10 years old)

Students are expected to know:

- Digital and analogue time including the 24 hour clock and the 12 hour clock.
- The main ideas behind Greenwich Mean Time and British Summer Time.
- How to read the time to the minute and read more complex train timetables with gaps missing.

Key Stage 2: Year 6 (10-11 years old)

Students learn to read world time charts, and are taught about the different times around the world.

Key Stage 3 and Key Stage 4: Year 7 to Year 10 (11-15 years old)

A greater emphasis is placed on timetables, and elapsed time, putting into practice the knowledge gained from previous teaching.

American Curriculum (Saxon Math Program, 2004)

Benchmark: First Grade students (6-7 years old) will understand and use various forms of measurement.

Performance Indicators regarding *Time*:

- Sequence events before and after: first, next, last.
- Compare duration of events: which takes more or less time.
- Read a clock face and tell time to the half-hour.
- Recall the days of the week and months of the year, both in and out of sequence.
- Understand orientation in time: today, yesterday, tomorrow, morning, afternoon, evening, night, this morning versus yesterday morning.

Benchmark: Second Grade students (7-8 years old) will understand time.

Performance Indicators:

- Decipher a clock face and tell time to five-minute intervals.
- Distinguish time as A.M. and P.M.
- Understand noon and midnight.
- Solve problems on elapsed time (how much time has passed).
- Using a calendar: identify the date, day of the week, month, and year.
- Formulate the date using words and numbers.

Benchmark: Third Grade students (8-9 years old) will understand time.

Performance Indicators:

- Read a clock face and tell time to the minute as either A.M. or P.M., tell time in terms of both "minutes before" and "minutes after" the hour.
- Solve problems on elapsed time (how much time has passed).
- Using a calendar, identify the date, day of the week, month, and year.
- Write the date using words (for name of month) and numbers, and only numbers.

Benchmark: Fourth Grade students (9-10 years old) will understand time.

Performance Indicators:

- Solve problems on elapsed time.

Benchmark: Fifth Grade students (10-11 years old) will understand time.

Performance Indicators:

- Consolidation of the topics covered in the first four grades
- Teaching of "common years" and "leap years" and introducing "decade", "century" and "millennium".
- Analogue time questions are randomly asked with elapsed time questions added for example: presented with an analogue clock time, the student is asked "What will the time be in three hours' time?"
- Elapsed time covering the period of several years will be studied.
- A greater emphasis is placed on timetables, and elapsed time, putting into practice the knowledge gained from previous teaching.

Benchmark: Sixth to Ninth Grade students (11-15 years old).

Performance Indicators:

- Putting into practice the knowledge gained from previous teaching with a greater importance placed on elapsed time and timetables.

3.3.2 Choosing the Criteria for Times

It was anticipated that at Key Stage 1 participants would make errors in reading the minute and hour hands and would show uncertainty about the 24 hour clock through lack of knowledge.

The criteria for selection of times in this experiment were based on the core knowledge presented in the National Numeracy Strategy (1999) at the three Key Stages. The aim was to choose questions which were demanding enough for all three age groups.

For the experiment, 120 analogue clocks were randomly presented. They were selected as follows and placed into three main categories:

Complexity 1: simple analogue and simple digital time representation (Simple Complexity)

Complexity 2: intermediate analogue and intermediate digital time representation (Intermediate Complexity)

Complexity 3: complex analogue and complex digital time representation (Complex Complexity)

3.3.2.1 Complexity 1 - Simple Time Selection

The definition of *simple analogue and simple digital time representation* falls into two categories in accordance with National Numeracy Strategy. During Key Stage 1 a child should be able to read hours, quarter to, quarter past, and half past the hour on an analogue / digital clock. These were the most elementary of times so it was decided to choose 24 clocks which would fit these criteria. The 24 *simple times* were divided as follows for the minute hand: six hour times, six quarter past the hour times, six half past the hour times, and six quarter to the hour times. There were 12 matched and 12 mismatched times, 12 of which were displaying the digital time presented in 24 hour clock time.

These were selected randomly. The following procedure was carried out to randomise the choice. Twenty four hour times were written on 75x50 mm cards and then placed in a closed box, which was shaken for one minute. Cards were then withdrawn randomly from the box without being replaced, until six hour cards were chosen.

Twenty four simple times were chosen by preparing cards with half hour, quarter past and quarter to the hour times and selecting them randomly with the hour cards already prepared. Cards were shaken in a box for one minute and drawn randomly until all 18 were selected.

3.3.2.2 Complexity 2 - Intermediate Time Selection

The definition of *intermediate analogue and intermediate digital time representation* falls into two categories in accordance with the National Numeracy Strategy (1999). These are times which fall into the five minute intervals around the clock face. By the end of Key Stage 1, times being presented at five minute intervals are taught, so it was decided to select 20 times which fitted these criteria. These were described as *intermediate times.*

A student in Year 3 at Key Stage 2 is expected to read the time to five minutes on a digital and analogue clock and to recognise 8:35 as 35 minutes past eight or 25 minutes to nine. In addition, through Year 4, students learn to treat the time to the minute on a 12 hour digital clock and analogue clock.

They should know, for example, that 4:37 equates to 37 minutes past four, or 23 minutes to five as an equivalent.

Intermediate times were chosen by preparing eight five minute interval cards and 24 hour cards which were placed in two separate boxes, shaken for one minute and randomly selected without replacing. The 15 minute, 30 minute, 45 minute and hour times were not included.

There were 10 matched and 10 mismatched times, 10 of which displayed the digital time presented in 24 hour clock mode.

3.3.2.3 Complexity 3 - Complex Time Selection

The definition of *complex analogue and complex digital time representation* is based on the core knowledge gained by the end of Key Stage 2 and the start of Key Stage 3. A child is expected to be able to read a digital and analogue clock to single minutes and to be aware of the 24 hour clock illustration.

Times representing the complex analogue clock were written on cards as before. Twenty four hour cards and 60 minute cards were placed in two boxes, shaken vigorously and selected at random, replacing the cards each time. It was important that the exact presentation was correct with respect to layout for authenticity. From these permutations the required selection of 20 were chosen. There were 10 matched and 10 mismatched times, 10 of which displayed the digital time presented in 24 hour clock mode.

Two further time selections were made to complete the experimental time choices. One selection was chosen based on the orientation of the minute and hour hands. It was decided to prepare 40 clocks that displayed times where the hands lay at exactly 90° and 180° to one another. For final analysis, these clocks were subsequently placed in one of the three complexity groups in accordance with the group criteria.

The final clock selection was based on mistakes, where the hours and minute times were interchanged on the digital time against the analogue time where possible. This group of times was comprised of 16 clocks. There were eight matched and eight mismatched times, eight of which displayed the digital time presented in 24 hour clock mode (e.g., analogue 16:49 versus digital 15:49). For analysis purposes, these times were combined in accordance with the main complexity criteria. Their selection was randomised in the same way as the other time questions.

On completion of the selection, every time was drawn on a standardised analogue clock face with the digital comparative time presented in the lower right corner of the image. This was checked for authenticity, repeatability, and appropriateness based on the anticipated response. This was achieved by carrying out a pilot study and asking an independent sample of children for their opinion of the questions. The selections were then scanned into the computer, and randomised, in preparation for the final presentation (see Figure 3).

The clock variations were drawn as a bitmap image on the computer and these images were assigned a unique number and selected by the test software in the final random order (see Table 3.5).

Table 3.5 summarizes the analogue clock times chosen for the experiment.

Table 3.5: Random Stimuli Selection for Time Experiment

	Simple Analogue				*Intermediate Analogue*	*Complex Analogue*	*90°,180°*		*Mistake*
Time 120	*Hour 6*	*Qtr Past 6*	*Half Past 6*	*Qtr To 6*	*20*	*20*	*40*		*16*
01:00			01:30		01:25	01:15	01:05	15:03	01:45
02:00	02:00			02:45	01:35	02:13	13:22	03:13	
03:00			03:30		02:55	03:21	02:27	16:19	03:57
04:00	04:00				04:35	04:18	14:43	04:33	
05:00		05:15			05:05		03:33	05:48	
06:00					05:55	06:15	16:06	18:26	05:43
07:00				07:45	06:40		04:38	06:58	06:37
08:00			08:30		07:25	08:15	17:27	07:01	07:39
09:00		09:15			09:10		17:43	07:51	09:39
10:00						10:45	06:33	20:08	09:59
11:00	11:00	11:15			11:35	11:49	18:49	21:19	11:49
12:00				12:45		12:30	19:38	09:39	
13:00	13:00				13:10	13:15	07:55	23:11	15:20
14:00		14:15			14:05	15:37	08:27	11:49	
15:00					15:40	15:45	21:33	23:56	
16:00				16:45		16:26	09:49	00:08	16:49
17:00			17:30		16:10		22:22		17:23
18:00			18:30		18:25	17:15	22:39		
19:00	19:00	19:15				18:31	10:54		
20:00				20:45	20:50	19:51	11:44		21:46
21:00			21:30		22:10	21:30	01:08		22:07
22:00	22:00	22:15			22:55	23:02	13:32		23:42
23:00				23:45	23:50	23:57	14:19		23:57
00:00					12:20	00:10	02:46		00:45

Note: times presented in blue are 24 hour times.

Qtr = Quarter

The numbers given in the headings represent the total number of questions asked in each case.

3.3.3 Presentation

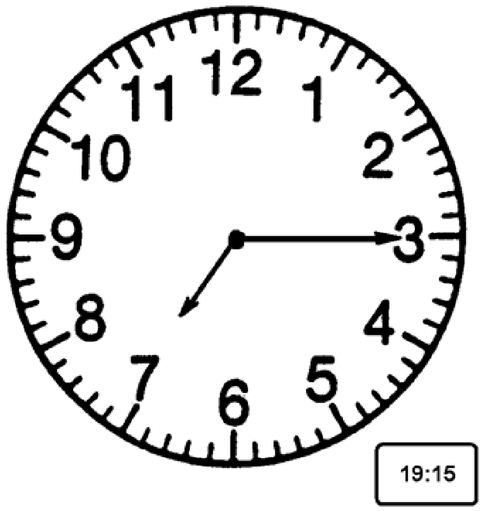

Figure 3: Analogue Clock Presentation

A plain analogue clock design was chosen (see Figure 3), clearly showing the minute scale between large numeral hours. The hours were presented on the inside face of the dial. The digits and minute marks were displayed in black on a white background, with the hands clearly placed on the face. They were proportionally correct in size with an arrow pointer on the end.

The scanned faces of the selected time questions were stored as bitmap images on the computer, in order for the software to select them in the specified random order. When presented to the participant, the image was 195mm in diameter, with black numerals in "Western" font and black hands on a white background, filling the screen. The digital time presented for comparison was placed in a bordered box, set in the lower right corner of the screen just below the clock face. This box measured 45mm long by 25mm high. Inside, the digital figures were of Arial Bold of font size 14.

The positioning of this digital time box to the lower right corner of the display was adopted as a result of findings from research carried out by Eden et al. (2003). This paper provided behavioural evidence that children with dyslexia neglected the left side of the image when they drew the clock face. Hence, in order to give the dyslexic participants every opportunity, it was decided to place the digital representation on the lower right side.

3.3.4 SuperLab Pro Software

SuperLab Pro software was used to build this experiment. The collected data for this research, which includes reaction time and accuracy, was saved in text-only files which could be read by spread-sheet or statistics software.

SuperLab Pro data was saved in text-only files with columns separated by tabs, allowing the data to be imported into an Excel spread-sheet and subsequently exported to SPSS. This software has the capability of measuring accuracy and speed of response to the stimuli presented on the screen.

3.3.5 The Computer

A portable laptop computer was used for the experiment.

The experiment took place in a quiet room away from any disturbance. The computer was set up on a table in front of the participant with the clock presentations at eye height and the rake of the screen adjusted to each individual for comfort. The desktop screen was set to plain blue and the screensaver turned off.

A 3.5" floppy disk was installed to enable data capture and storage and each participant was assigned a unique reference number.

3.3.6 Ethical Considerations

The research was passed by the Ethics Committee of the University of Chester (2004). The conclusion was reached that there would be no undue stress or cause for anxiety as a result of the research for the participants. The schools involved would provide the liaison between parents and researcher. Parents received a letter from the researcher outlining the nature of the research and the testing which would take place. The letter went home via the school as the researcher had no access to the parents' addresses. The letter had a permission slip attached, which the parent signed to grant the researcher permission for their child to participate in the research experiment. The researcher agreed to keep the participants' names strictly confidential.

3.3.7 Pilot Study

A pilot study on five participants (two aged 7 years, one dyslexic the other not, two aged 11 years, one dyslexic the other not, and one dyslexic aged 14 years) was undertaken in order to prove the validity of both instruction and experiment. None of these participants took part in the final experiment. The wording chosen to guide the participant was checked for understanding. Running the pilot enabled a check on the reliability and repeatability of the experimental software. In addition, it gave the researcher the opportunity of testing the storage and retrieval of results. Further, the participants were able to guide the researcher as to the demands of the experiment. One change at this stage was recommended; that of splitting the experiment into two, with equal numbers of questions in each section. This gave the researcher an opportunity to provide a brief break in the experiment, for the children to regain composure. The experiment was split to present 60 questions in Part 1 and 60 questions in Part 2.

By splitting the time experiment into two smaller tests, presenting 60 questions in each test, two advantages were gained:

1. It was found that the working memory of the computer precluded 120 test questions from being stored, to access by the program, due to lack of RAM; the computer became overloaded.
2. Staging the experiment in a block of 120 questions was too exhausting. A natural break was built into the experiment of 10 minutes, between tests, which was welcomed by participants.

3.3.8 The Time Experiment Preamble

The stimuli were split into two equal parts, comprising 60 questions in Part 1 and 60 questions in Part 2. In addition, it was felt necessary to present a pre-test familiarisation exercise to enable participants to practise pressing the correct keys in response to the question. The process was simplified to a “yes” or “no” response, by pressing “Y” or “N” on the computer keyboard (standard QWERTY layout) or the “Space Bar” response if the answer was not known. All other keys were disabled to prevent accidental selection. Further, the “Y” and “N” keys were highlighted with a fluorescent spot and the “Space Bar” with a label entitled “Space Bar” to help with recognition.

3.3.9 Practice Exercise 1: Initial Familiarisation Task

Instruction Screen 1

To gain familiarisation of where the three response keys were to be found on the computer keyboard, two initial exercises were performed comprising three tasks. The participant was asked to follow the instruction presented on the screen in practice exercise 1 (see Figure 3.1) and then to perform Task 1 (see Figure 3.2) followed by Task 2 (see Figure 3.3).

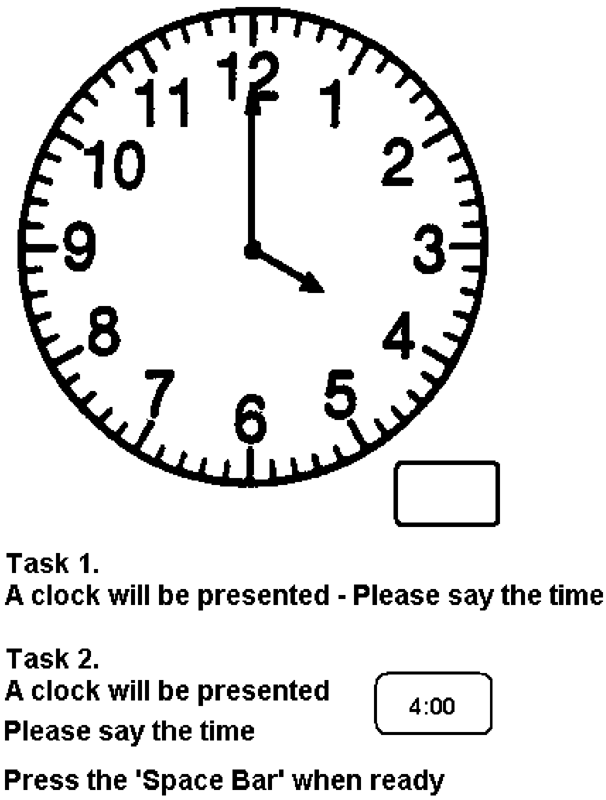

Figure 3.1: Practice Exercise 1 - Initial Familiarisation Task Instruction Screen

Clear verbal guidance was given to ensure that the participant understood the instruction on the screen. The participant was asked to follow the instructions to complete Task 1 and Task 2 of the first familiarisation exercise. The instruction was read aloud by the researcher to each participant in turn. This was to help with the understanding of the task.

Familiarisation Task 1 – Analogue Time

The participants were asked to read aloud in response to five analogue clocks presented on the screen when the “Space bar” was depressed (see Figure 3.2). Each time presentation was unique and could be answered as quickly as the participant wished. When the analogue time question was answered satisfactorily, the participant depressed the “Space Bar” key for the next time to be presented, until completion of Task 1. The researcher was able to monitor responses and provide help if it were necessary. The participants’ responses, however, were not recorded for the purpose of the experiment.

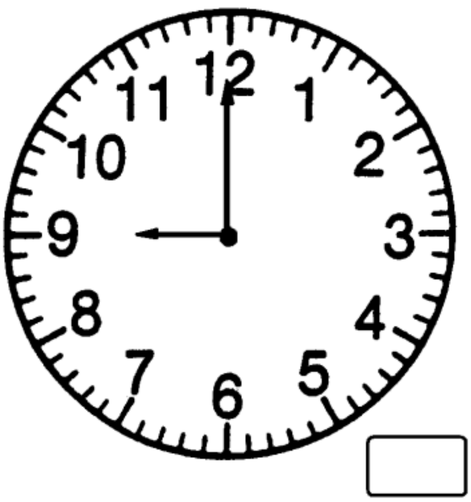

Figure 3.2: Familiarisation Task 1 – Analogue Time

Familiarisation Task 2 – Digital Time

The participants were asked to read aloud in response to five digital clocks presented on the screen when the “Space Bar” was depressed (see Figure 3.3). As with Task 1, each time presentation was unique and could be answered as quickly as the participant wished. When the digital time question was answered satisfactorily, the researcher instructed the participant to depress the “Space Bar” key for the next time to be presented, until completion of Task 2. The researcher was able to monitor responses and provide help if it were necessary. The participants’ responses, however, were not recorded for the purpose of the experiment.

Figure 3.3: Familiarisation Task 2 – Digital Time

3.3.10 Practice Exercise 2: Initial Familiarisation Task

Instruction Screen 2

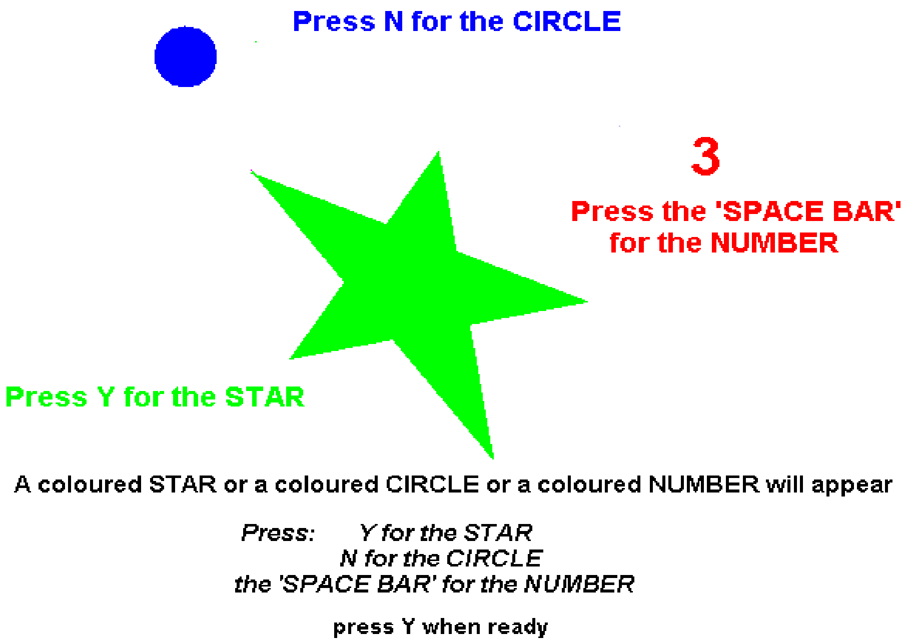

Figure 3.4: Practice Exercise 2 - Initial Familiarisation Task Instruction Screen 2

The second practice exercise involved answering directed stimuli questions. These directed questions guided participants to depress the three keys on the keyboard which would be used in the experiment. It served to give the participants the opportunity to practice locating and depressing the right keys in response to the on-screen question. The three keys used for the experiment were “Y” which represents “Yes”, “N” which represents “No” and the “Space Bar” for “Don’t know”. The three keys were marked with a fluorescent red spot on the “Y” and “N” keys and the “Space Bar” was labelled “Space Bar”. All other keys were disabled for the experiment. Further, the questions displayed on the screen were randomised in preparation for the *Time Comparison Experiment*.

The instruction page shown in Figure 3.4 appeared automatically on the screen and guidance was given to the participant by the researcher reading aloud the instruction page. In addition, the participants were reminded and shown which three keys they were to use.

On depressing the “Y” key, the practice exercise began (see Figure 3.5). Each new presentation whether it be: a number (Press ?) which represented “don’t know” [Space Bar], coloured circle (Press N) which represented “No”, or coloured star (Press Y) which represented “Yes”, encouraged a correct response by clearly stating on the picture stimulus which key to depress. Ten randomised responses were practised.

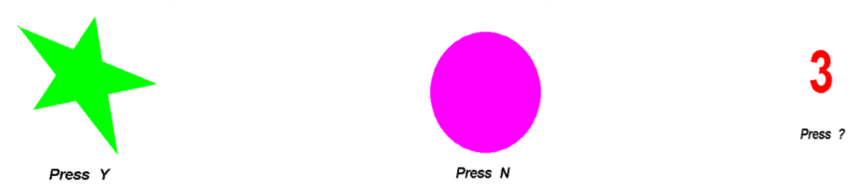

Figure 3.5: Practice Exercise 2 – Test Stimuli

During both exercises the participants were asked if they understood the instruction fully and if they were happy to continue. They were asked too, if they understood which three keys to press and were reminded again before the Time Comparison Experiment began.

In both of these practice exercises the participants worked at their own pace and the results were not recorded.

3.4 The Time Comparison Task

The Time Comparison Task (TCT) comprised 120 analogue clock face questions delivered in the order 1–120 (see “Ref” presented in Table 3.6). The “Bitmap image” number was the unique number assigned to the clock image and the “Time” was the time chosen for the experiment. These numbers did not appear in the presentation to the participant, and were for reference only. In the final analysis the “Time” number was used to provide reference.

Reference numbers **1-60** denoted clocks used in the first part of the experiment and reference numbers **61-120**, denoted clocks used in the second part of the experiment.

Each new clock question appeared when the response key was depressed on answering the previous question. Table 3.6 shows the analogue clock times (Time) as a number followed by a suffix “t” (true) or “w” (wrong). The number represents the actual analogue time of the clock and the suffix “t” represents the analogue time *matching* its corresponding digital time, whether it be 12 or 24 hour presentation. Similarly, the suffix "w" represents the *mismatched* digital time to its corresponding analogue time. For example: 2200t is 22:00 hours on the analogue clock (in the 24 hour clock time) and is matched with 22:00 on the digital time. In contrast, 1115w is 11:15 on the analogue clock which is accompanied by a mismatched digital time of 11:03.

During the time selection phase, two times 939w and 939wa and three different times 1149t, 1149w and 1149wa were drawn at random. It was decided to preserve this selection and so these times were assigned unique "wa" suffix notation to identify them from one another.

Table 3.6 shows the randomly selected time comparison questions presented on the computer in the order they appear to the participant.

Table 3.6: Time Order Selected for the Experiment

Ref	Bitmap image	Time	Ref	Bitmap image	Time	Ref	Bitmap Image	Time
1	86	1727w	41	90	1826w	81	60	1149w
2	92	1831w	42	52	959t	82	45	827t
3	37	658w	43	105	2146t	83	49	939w
4	87	1730t	44	17	255t	84	62	1230t
5	22	357w	45	44	815w	85	8	125w
6	101	2119t	46	84	1715t	86	98	2008t
7	56	1115w	47	4	0045t	87	82	1645w
8	108	2210w	48	42	751w	88	47	910t
9	67	1322t	49	58	1144t	89	39	725w
10	33	615t	50	103	2130w	90	120	2357w
11	71	1419t	51	13	213w	91	113	2302w
12	76	1540t	52	38	701t	92	15	245t
13	66	1315w	53	18	313w	93	112	2255t
14	79	1610t	54	115	2342w	94	53	1045t
15	19	321w	55	48	915t	95	21	333w
16	59	1149t	56	106	2200t	96	1	0008t
17	110	2222t	57	72	1443w	97	41	745t
18	50	939wa	58	51	949t	98	27	438t
19	75	1537t	59	9	130t	99	12	200t
20	80	1619t	60	20	330w	100	32	555w
21	3	1220t	61	40	739t	101	64	1300t
22	28	505t	62	30	543t	102	81	1626w
23	119	2357t	63	78	1606w	103	83	1649w
24	23	400w	64	114	2311w	104	63	1245w
25	5	105w	65	96	1938t	105	93	1849w
26	61	1149wa	66	99	2045w	106	102	2130t
27	16	246t	67	117	2350w	107	46	830t
28	97	1951t	68	57	1135w	108	95	1915t
29	65	1310w	69	25	433t	109	10	135t
30	29	515t	70	35	637w	110	68	1332w
31	43	755w	71	88	1743t	111	94	1900w
32	34	633t	72	7	115t	112	24	418t
33	36	640w	73	2	0010w	113	55	1100w
34	74	1520t	74	69	1405t	114	31	548t
35	118	2356t	75	104	2133w	115	26	435w
36	89	1825w	76	14	227w	116	73	1503w
37	85	1723t	77	111	2239w	117	116	2345t
38	6	108w	78	109	2215w	118	91	1830w
39	11	145t	79	70	1415w	119	77	1545w
40	54	1054w	80	100	2050t	120	107	2207w

3.4.1 The Experimental Test Procedure

At the start of the test procedure, participants were asked to type into the computer their name followed by the reference number 1 which represented the first part of the experiment, and their name followed by a 2 representing the second part of the experiment. This enabled the easy collation of data, which was then combined for each individual at the analysis stage. Data was stored to a 3.5" floppy disk which was given the school's name as a reference.

When the program was begun the participants were presented with an instruction page which was read out aloud to them (see Figure 3.6).

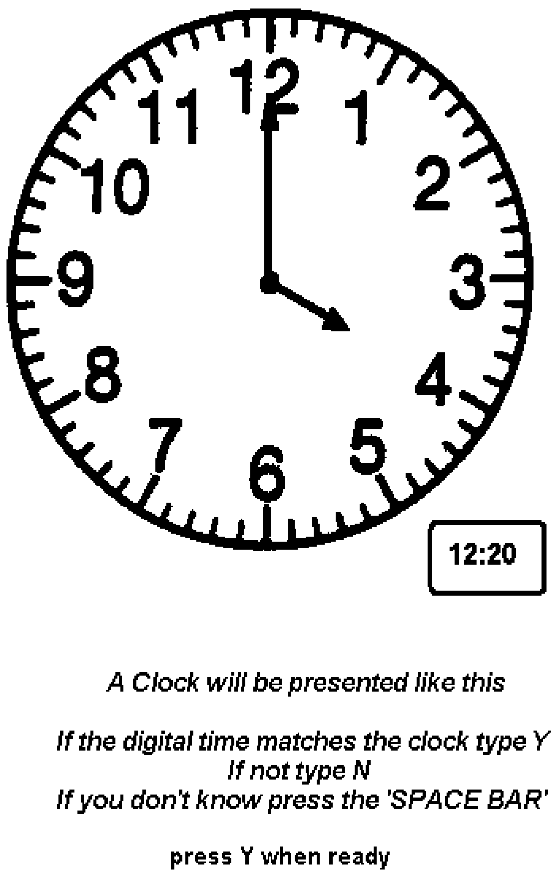

Figure 3.6: Time Experiment Instruction Page

Once the instruction was given, the participants were asked if they were sitting comfortably, and that the rake of the screen suited them. They were asked if they understood what to do and they were told that on pressing the "Y" key the experiment would begin. They were told that they would need to answer the questions as quickly and as accurately as possible. The participants were asked which response they would choose in answering the instruction page, which presented a mismatched analogue to digital time; to which a no (N) answer was required. With this accurate response the researcher was satisfied that the instructions were understood. Participants were instructed, however, to depress the "Y" key for the programme to start. They were also advised to press the "Space Bar", if they had no idea of the answer, otherwise they might worry, fret, or ponder with time ticking away.

3.4.2 Result Collection

On completion of the first set of 60 questions (**1-60**), the participants were asked to sit quietly for the researcher to check that their responses were stored to disk. When this was confirmed and completed the researcher set up the second 60 (**61-120**) questions for the participant to attempt. As before, the instruction page was presented to remind the participant what they needed to do. It was read out loud to check for understanding prior to the start of the last part of the experiment. On completion, the results were checked for completeness and the participant was free to go.

Data collected from the time experiment were transferred from the Superlab program and imported into Excel as a complete set of results for each participant and then imported to SPSS (a statistics program), for evaluation.

3.4.3 Certificate and Feedback

Each participant who was chosen to take part was awarded a Certificate of Appreciation from the researcher. In addition, feedback in the form of a short report was presented to the schools for their record and to pass on to parents. This report summarised the results of the preliminary phases of testing – Bangor Dyslexia Test, Schonell Spelling Test and the Raven Progressive Matrices Test.

3.5 Results – Accuracy

The experiment was designed to measure the accuracy of responding to visually presented clock stimuli shown on a computer, for time related questions. Accuracy in this experiment is defined as the correct response to these stimuli. These results represent this measurement for the accurate responses to matched and mismatched clock faces only.

When looking at accurately recognising clock times in this time comparison experiment, the following two questions are examined:

1. *When performing the operation of accurately recognising clock times will dyslexics be less accurate than non-dyslexics?*
2. *Will younger dyslexics be less accurate than older dyslexics?*

Prior to the analysis, a number of missing values were replaced. These were based on individuals who failed to get any item correct for any one unique condition, for example, for an analogue clock face presented at first quartile in the simple condition, with a matching digital clock face. If accuracy data were missing across all items reflecting this unique combination of the three variables (quartile, complexity, correctness) making up this condition, then that particular cell had a mean introduced, based on that participant's scores for the remaining three quartile clock faces in the simple category for matching clocks. In all, there was 1.1% (32/2880) replacement of the data, which received this treatment. To assign analogue times to each quartile for analysis, a decision was taken to use the hour hand as the quartile determinant. All non-reported effects are non-significant.

For descriptives and inferential results appearing in Chapter 3, see Appendix B which gives results for accuracy.

Table 3.7 presents a summary of the mean accuracy for each Quartile by Group and Age.

Table 3.7: Summary of the Mean Accuracy for Quartiles by Group and Age

	Group	Age	Mean %	Std. Deviation	N
Quartile 1	Control	7 year old	53.85	21.029	20
		11 year old	93.08	7.445	20
		14 year old	92.69	9.161	20
		Total	79.87	23.059	60
	Dyslexic	7 year old	48.08	18.822	20
		11 year old	76.54	22.389	20
		14 year old	91.54	08.964	20
		Total	72.05	25.135	60
Quartile 2	Control	7 year old	41.82	21.754	20
		11 year old	89.09	13.058	20
		14 year old	90.91	11.036	20
		Total	73.94	27.780	60
	Dyslexic	7 year old	35.45	23.017	20
		11 year old	63.18	29.120	20
		14 year old	84.55	17.224	20
		Total	61.06	30.822	60
Quartile 3	Control	7 year old	50.50	25.021	20
		11 year old	94.50	7.592	20
		14 year old	96.00	08.208	20
		Total	80.33	26.359	60
	Dyslexic	7 year old	39.00	19.708	20
		11 year old	72.00	30.539	20
		14 year old	91.00	13.338	20
		Total	67.33	30.856	60
Quartile 4	Control	7 year old	38.13	23.639	20
		11 year old	92.50	10.458	20
		14 year old	92.50	8.507	20
		Total	74.38	30.111	60
	Dyslexic	7 year old	31.88	17.897	20
		11 year old	67.50	22.269	20
		14 year old	86.56	12.043	20
		Total	61.98	28.844	60

3.5.1 Accuracy Results

A five-way mixed ANOVA was performed on the accuracy means. The two between participant factors were Group (dyslexic and control) and Age (seven year old, 11 year old and 14 year old). The three within participant factors were Quartile (4 quartiles of the clock), Complexity (simple, intermediate and complex) and Correctness (matched and mismatched response).

There was a main effect of Age, $F(2,114) = 117.6$ $p=.001$. Pair-wise comparisons revealed a significant difference between the seven year old and 11 year old groups

(p=.001) and seven year old and 14 year old (p=.001) and the 11 and 14 year old groups (p=.006). It was observed that the accuracy for seven year olds (mean = 40.2%; Standard Error = 2.3) was less than the 11 year olds (mean = 78.2%; SE = 2.3) and also the 14 year olds (mean = 87.3%; SE = 2.3). There is no difference between 11 and 14 year olds (t=1.8; df=38; p=ns). There was a two-way interaction between Group and Age, F(2,114) = 3.99, p=.037 as can be seen in Figure 3.7. For seven year olds, the controls differ from the other control groups (t(38)=7.29; p<.001), but 11 and 14 year olds do not differ. For the dyslexic group there is a difference (t(38)=6.04; p<.001) between 11 and 14 year olds too. The descriptives table of mean accuracy is presented in Appendix B.1. The independent t-test tables are presented in Appendix B.2, B.3 and B.4.

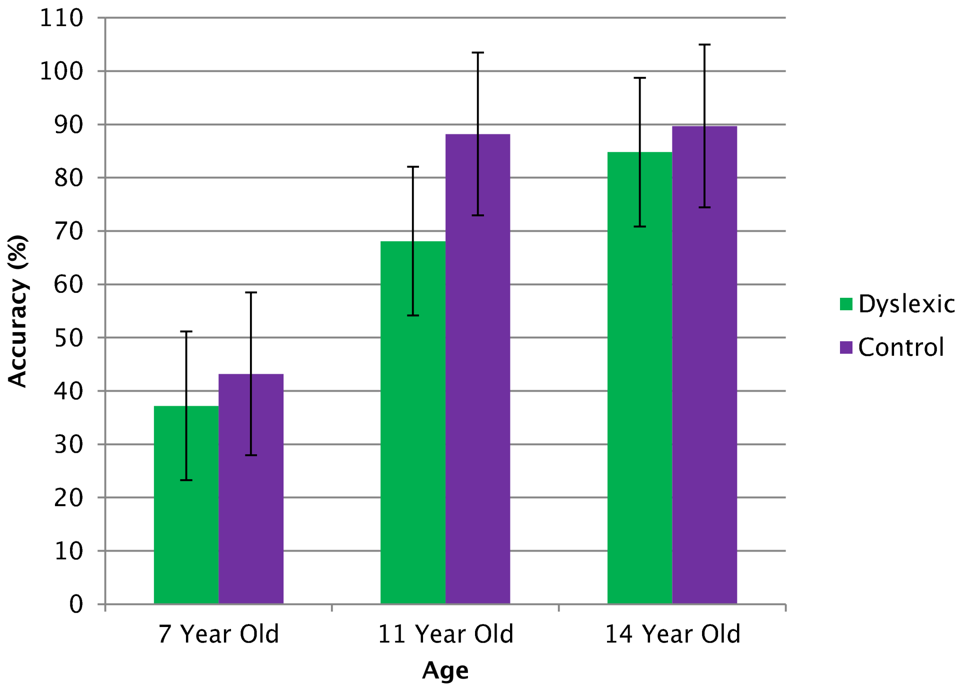

Figure 3.7: Mean Accuracy for Group by Age

No other interactions either between or within factors occurred with the Age factor. This suggests that there is a quantitative difference in performance between the seven year old participants and the 11 and 14 year old participants, as anticipated.

The following analyses split the sample into two. One examines the 11 and 14 year old age groups and retains the Age comparison. The second series of analyses includes the seven year, 11 year and 14 year groups, but only for the Simple complexity clock face materials. These materials were designed to be Key Stage appropriate for the seven year olds and should demonstrate equivalent levels of performance. This series of analyses is reported first.

3.5.2 Simple Clock Faces Only

The analysis was a four-way mixed ANOVA, Group (dyslexic and control), Age (seven year old, 11 year old and 14 year old) and within subject factors, Quartile (4 quartiles of the clock) and Correctness (matched and mismatched response) for the simple complexity clock faces only.

There is a main effect of Group, $F(1,114) = 16.1$, $p=.001$, simply showing that the controls' performance (mean = 78.9%; SE = 2.0) was higher than the dyslexic performance (mean = 67.6%; SE = 2.0) and also for Age, $F(2,114) = 99.0$, $p=.001$. Seven year old participants across both the control and dyslexic groups (mean = 45.4%; SE = 2.5) performed less well than 11 year (mean = 83.0%; SE = 2.5) and 14 year old participants (mean = 91.3%; SE = 2.5). This was confirmed by LSD pairwise comparison and again confirms the reasoning for splitting the seven year old participants from the older age groups. The pairwise comparison between the three ages showed significance across all three age bands, though the level of significance was less between 11 and 14 year olds ($p=.019$).

There was also an interaction between Age and Group, $F(2,114) = 4.03$, $p=.020$. Figure 3.8 shows that the accuracy of the control groups is consistently better than the dyslexic groups. The 11 year old control group was 22.1% better than the dyslexic group, though this 'gap' narrows by the age of 14 years to 2.7%. The descriptives table of mean accuracy is presented in Appendix B.5.

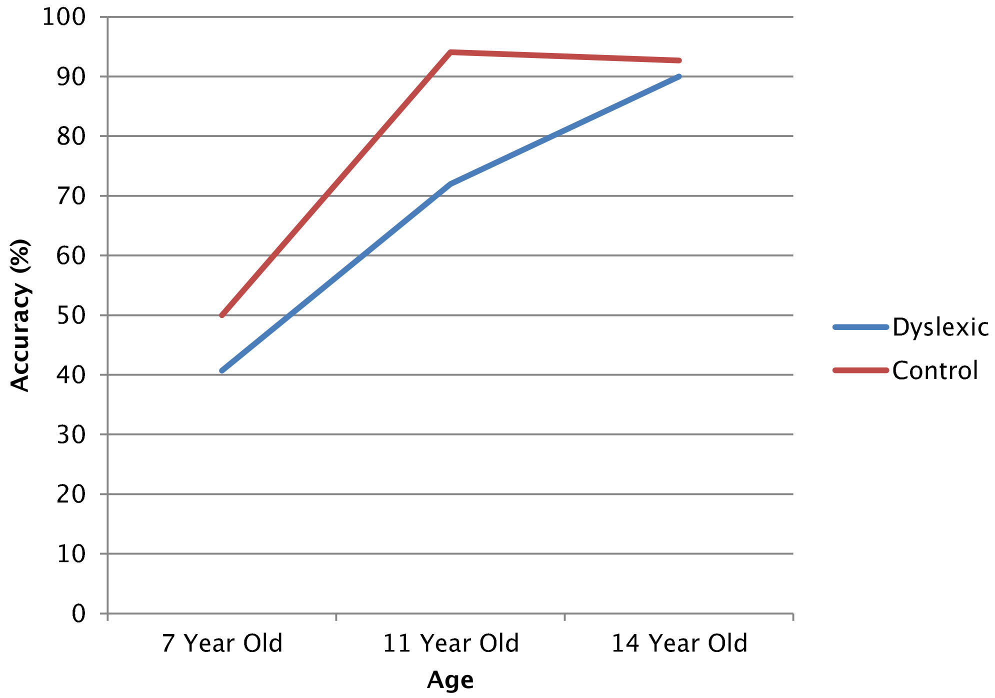

Figure 3.8: Interaction Between Age by Group – Simple Clock Faces Only

There was a three-way interaction between Correctness, Group and Age, $F(2,114) = 3.64$, $p=0.029$. This three-way interaction was explored in more detail by separating the two levels of correctness, matched and mismatched clock faces and performing two separate analyses of variance. There were two further two-way interactions: Correctness by Group, $F(1.0,114) = 7.97$, $p=0.006$ and Correctness by Age, $F(2.0,114) = 4.034$, $p=0.02$. The reader is referred to sections 3.5.2.1 and 3.5.2.2 below.

3.5.2.1 Matched Clock Faces for Simple Clock Faces only

A two-way ANOVA for Group by Age was conducted. There was a main effect of Group $F(1,114) = 24.6$, $p=.001$ with the controls' performance (mean = 80.6%; Standard Error = 2.3) being higher than the dyslexic performance (mean = 64.5%; SE = 2.3). There was also a main effect of Age, $F(2,114) = 94.5$, $p=.001$ and a two-way interaction of Group by Age, $F(2,114) = 5.3$, $p=.006$ (Greenhouse-Geisser corrected). Figure 3.9 shows that the accuracy performance for simple matched clock faces by the dyslexic participants is weaker in the younger years though there is steady improvement with age. The descriptives table of mean accuracy is presented in Appendix B.6.

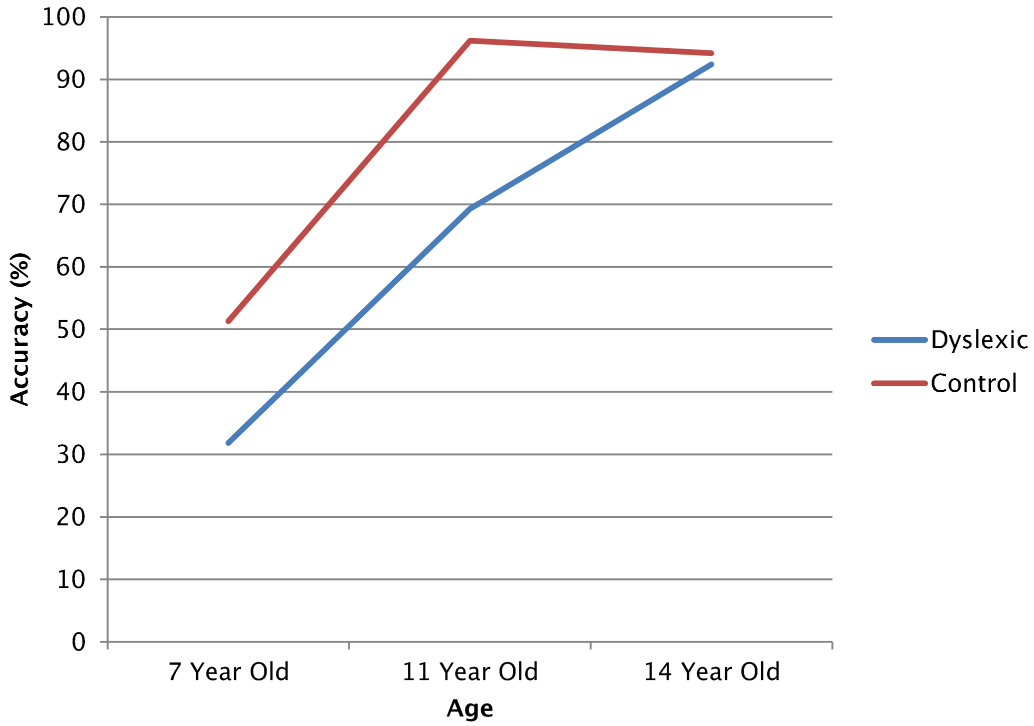

Figure 3.9: Interaction Between Group by Age – Simple Matched Clock Faces Only

3.5.2.2 Mismatched Clock Faces

A two-way ANOVA for Group by Age was conducted. There was a significant effect of Group, *F(*1,114) = 3.97, *p*=.049 with the controls' performance (mean = 77.3%; Standard Error = 2.4), higher than the dyslexic performance (mean = 70.6%; SE = 2.4). There was also a main effect of Age, *F(*2,114) = 55.9, *p*=.001 and a two-way interaction of Quartile by Group, *F*(2.7, 306) = 2.93, *p*=0.039 GG (see Figure 3.10). The descriptives table of mean accuracy is presented in Appendix B.7.

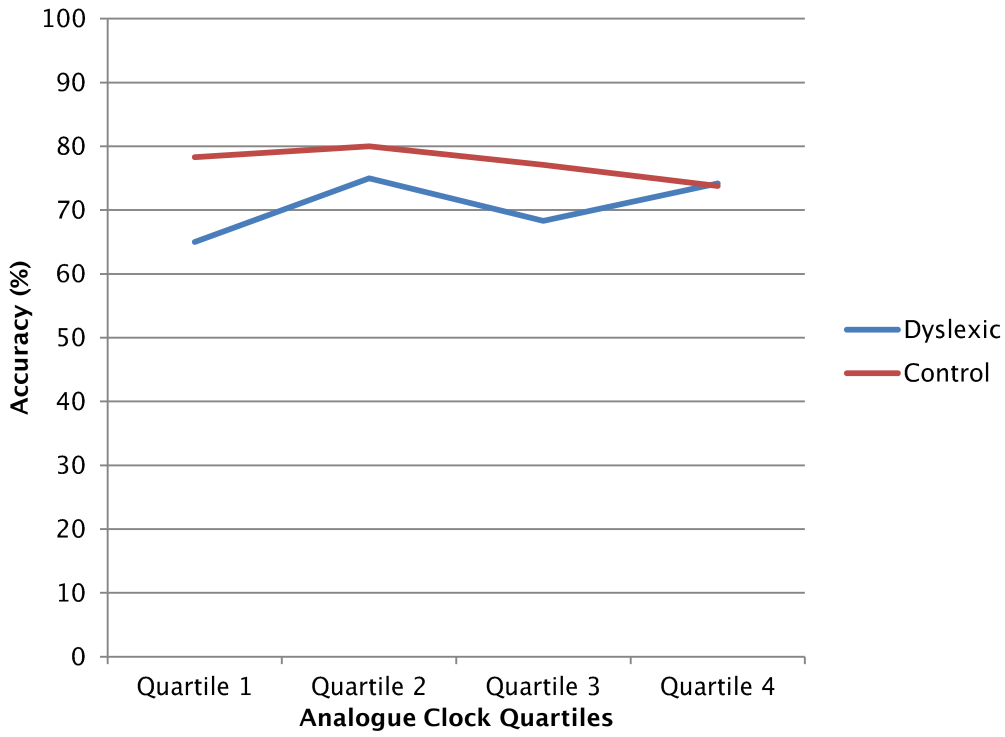

Figure 3.10: Interaction Between Group by Quartile for Simple Mismatched Clock Faces

Figure 3.10 appears to show a trend for the control participants with performance declining from quartile 2 through to quartile 4; however, Tukey pairwise comparisons revealed no quartile effect for controls. In contrast, dyslexic participants appear to show an erratic pattern of performance across the four quartiles. Tukey pairwise comparisons revealed quartile 2 was significantly more accurate than quartile 1 (p=.029). This may be better understood by comparing it with the equivalent figure for the matched clock faces. The descriptives table of mean accuracy is presented in Appendix B.8.

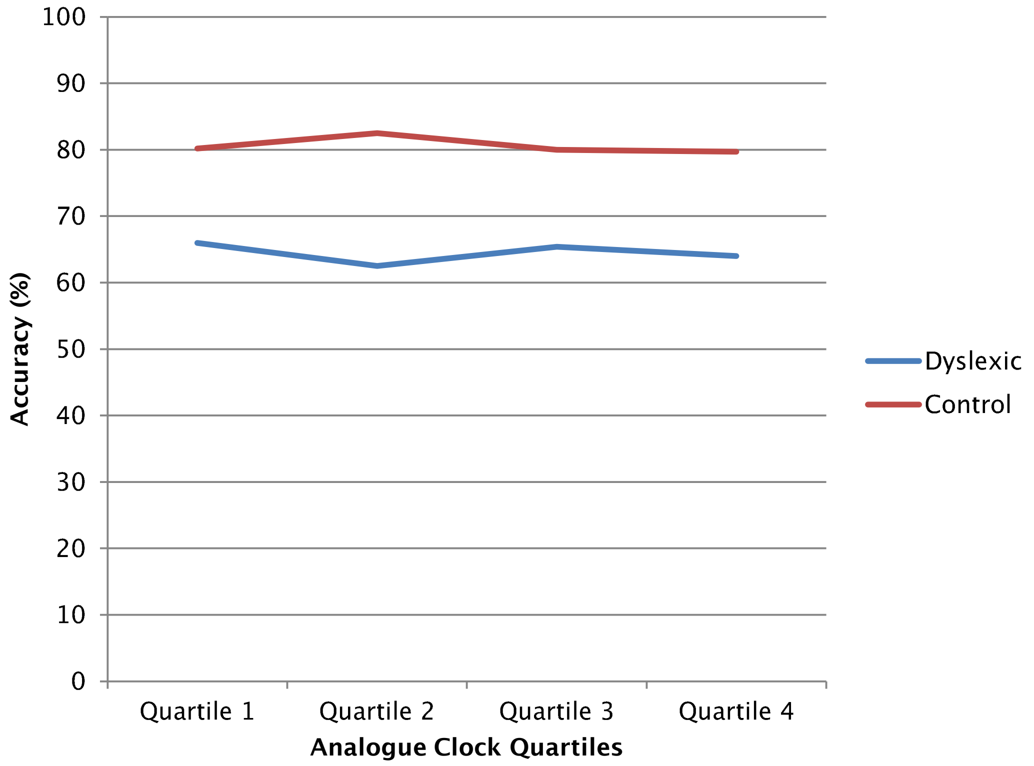

Figure 3.11: Interaction Between Group by Quartile for Simple Matched Clock Faces

In Figure 3.11 there is a clear main effect of performance with the control participants performing at a high level across all quartiles. In contrast, the dyslexic participants' performance is more linear between quartiles. Indeed for the dyslexic participants their performance for the mismatched clock faces (mean = 70.6%; SE= 2.4) was higher than their performance for the matched clock faces (mean = 64.5%; SE 2.3), whereas intuitively, for the control participants their performance was higher for the matched clock faces (mean = 80.6%; SE = 2.3) than the mismatched clock faces (mean = 77.3%; SE = 2.4). There was an interaction between Group and Correctness which was significant (p=.006).

3.5.3 Eleven and Fourteen Year Olds Only – Intermediate and Complex Faces Only

The analysis employed was a five-way mixed ANOVA, Group (dyslexic and control) and Age (11 year old and 14 year old) by Quartile (4 quartiles of the clock) and Correctness (matched versus mismatched) by Complexity (Intermediate and Complex clock faces only).

There were main effects for Group *F* (1,76) = 17.5, *p*=.001; Age, *F*(1,76) = 10.03, *p*=.002; Quartile, (means = Q1 0.84; Q2 0.79; Q3 0.78 and Q4 0.81), *F(*2.66,202.4) = 5.35, *p*=.002; Complexity, (means = Matched 0.79; Mismatched 0.82), *F(*1,76) = 14.74, *p*=.001; and Correctness, (means = Intermediate 0.79 and Complex 0.82). *F(*1,76) = 7.24, *p*=.009 (Greenhouse-Geisser corrected).

There were a series of two-way interactions including Quartile by Correctness, *F(*2.74, 208.4) = 6.94, *p*=.001 (Greenhouse-Geisser corrected); Quartile by Complexity, *F(*2.73,207.7) = 16.87, *p*=.001 (GG); and Correctness by Complexity F(1,76)=12.35, p=.001. Interpretation of the two-way interactions is not of theoretical interest as they do not include Group. Equally, they are also mediated by the presence of a series of three and four-way interactions.

There was a three-way interaction between Quartile by Complexity by Group, *F*(2.73,207.7) = 2.86, *p*=.043 (GG); and Quartile by Correctness by Complexity, *F(*2.28,173.5) = 10.10, *p*=.001 (GG).

There was a series of two four-way interactions which may make further interrogation of the three-way interactions superfluous. As such, each of the following four-way interactions will be explored by splitting out factors in a manner that addresses the questions.

3.5.3.1 First of Two 4-way Interactions

A four-way ANOVA for Group by Age by Quartile and by Correctness was conducted. There was a four-way interaction between Quartile by Correctness by Group and by Age, *F(*2.74,207.7) = 2.81 *p*=.045 (GG). To explore in further detail this complex pattern of results two follow-up analyses were performed for each level of the factor complexity.

3.5.3.1.1 Intermediate Complexity Faces Only - All Greenhouse-Geisser Corrected (GG)

Separating out Complexity, a four-way ANOVA for Quartile by Correctness by Group by Age was conducted. There were two independent group main effects, one of Age, *F(*1,76) = 6.44, p=.013, 11 year olds performed less well (mean = 75.0%; Standard Error = 2.2) than the 14 year olds (mean = 82.8%; SE = 2.2). There was also a main effect of Group, *F(*1,76) = 12.47, *p*=.001. Dyslexic participants performed less well (mean = 73.5%; SE = 2.2) than control participants (mean = 84.4 %; SE = 2.2). There was a main effect for Quartile, *F(*2.5,190.4) = 7.3, *p*=.001; pairwise comparisons revealed that quartile 1 showed a significantly higher performance compared with the other quartiles (all *p*s<.001); no other quartile differed. There was also a main effect of Correctness, $F(1,76) = 18.63$, $p=.001$. However, there was a two-way interaction between these two factors, Quartile by Correctness, $F(2.28,173.4) = 15.35$, $p=.001$.

To follow this two-way interaction further, any influence of quartile was examined for matched versus mismatched correctness factors separately.

3.5.3.1.2 Matched Clock Faces

Separating out Correctness a three-way ANOVA for Quartile by Group by Age was conducted. For matched clock faces (intermediate) there was a main effect of Quartile, $F(1.64, 124.9) = 6.75$, $p=.003$ (GG). Tukey pairwise comparisons revealed quartile 2 accuracy was higher than quartile 3 ($p=.002$) and quartile 4 ($p=.034$). In addition, quartile 1 was significantly more accurate than quartile 3 ($p=.008$), (see Figure 3.12).

3.5.3.1.3 Mismatched Clock Faces

Separating out correctness a three-way ANOVA for Quartile by Group by Age was conducted. For mismatched clock faces (intermediate) there was a main effect of Quartile, $F(2.31, 175.5) = 18.40$, $p=.001$ (GG). Tukey pairwise comparisons revealed quartile 1 accuracy was significantly higher than all other quartiles (all $ps=.001$). In contrast, quartile 2 was significantly less accurate than quartile 3 ($p=.001$) and 4 ($p=.004$).

Figure 3.12 shows the accuracy performance between the matched and mismatched clock faces for the intermediate clocks only. The descriptives table of mean accuracy is presented in Appendix B.9.

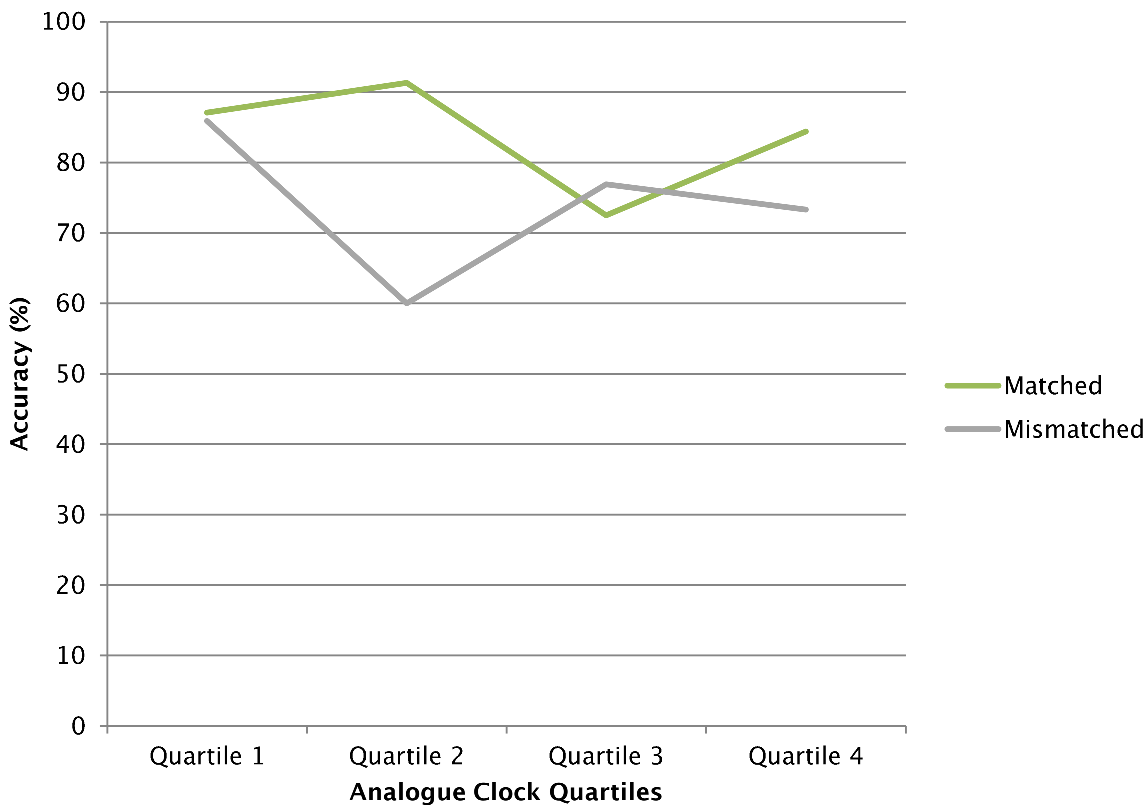

Figure 3.12: Interaction Between Correctness by Quartile for Intermediate Clock Faces Only

To follow this two-way interaction, a series of post-hoc repeated measures *t*-test comparisons for each quartile (adjusted alpha level of $p<0.0125$) revealed a significant difference in performance for matched faces compared to mismatched clock faces for quartile 2, $t(df = 79) = 6.97$, $p=.001$ and quartile 4, $t(df = 79) = 2.87$, $p=.005$ only. As this is true for both control and dyslexic groups it is interesting, but not of central theoretical interest.

3.5.3.1.4 Complex Faces Only

Separating out Complexity, a three-way ANOVA for Quartile by Group by Age was conducted. There was a main effect of Age, $F(1,76) = 11.1$, $p=.001$; Group, $F(1,76) = 17.9$, $p=.001$ and a two-way interaction between Age and Group, $F(1,76) = 5.74$, $p=.019$. Eleven year old participants performed less well (mean = 76.5%; Standard Error = 2.4) than 14 year old participants (mean = 87.7 %; SE = 2.4) and the dyslexic participants performed less well (mean = 75.0%; SE = 2.4) than control participants (mean = 89.2 %; SE = 2.4). The dyslexic group started to catch up by age 14.

There was a two-way interaction between Quartile and Correctness, $F(3,228) = 4.87$, $p=.003$ and a two-way interaction between Correctness and Group, $F(1,76) = 8.7$, $p=.004$. The latter is mediated by a three-way interaction between Correctness, Group and Age, $F(1, 76) = 7.4$, $p=.008$.

3.5.3.2 Analysis of 11 Year Olds Only

Separating by age a three-way ANOVA for Group by Age by Complexity was conducted. There was a main effect of Group with control participants performing better than dyslexic participants overall, $F(1,38) = 14.35$, $p=.001$ (see Figure 3.13). Splitting this three-way out by Age revealed that for 11 year olds there was also a two-way interaction of Group by Correctness, $F(1,38) = 15.66$, $p=.001$. Examining 11 year old participants only, results for correctness showed that the controls performed better on the matched clock faces compared to mismatched, $t(df=19) = 4.6$, $p=.001$ while in contrast the dyslexic participants performed marginally better on mismatched clock faces compared to matched, $t(df=19) = 2.24$, $p=.037$. The descriptives table of mean accuracy is presented in Appendix B.10.

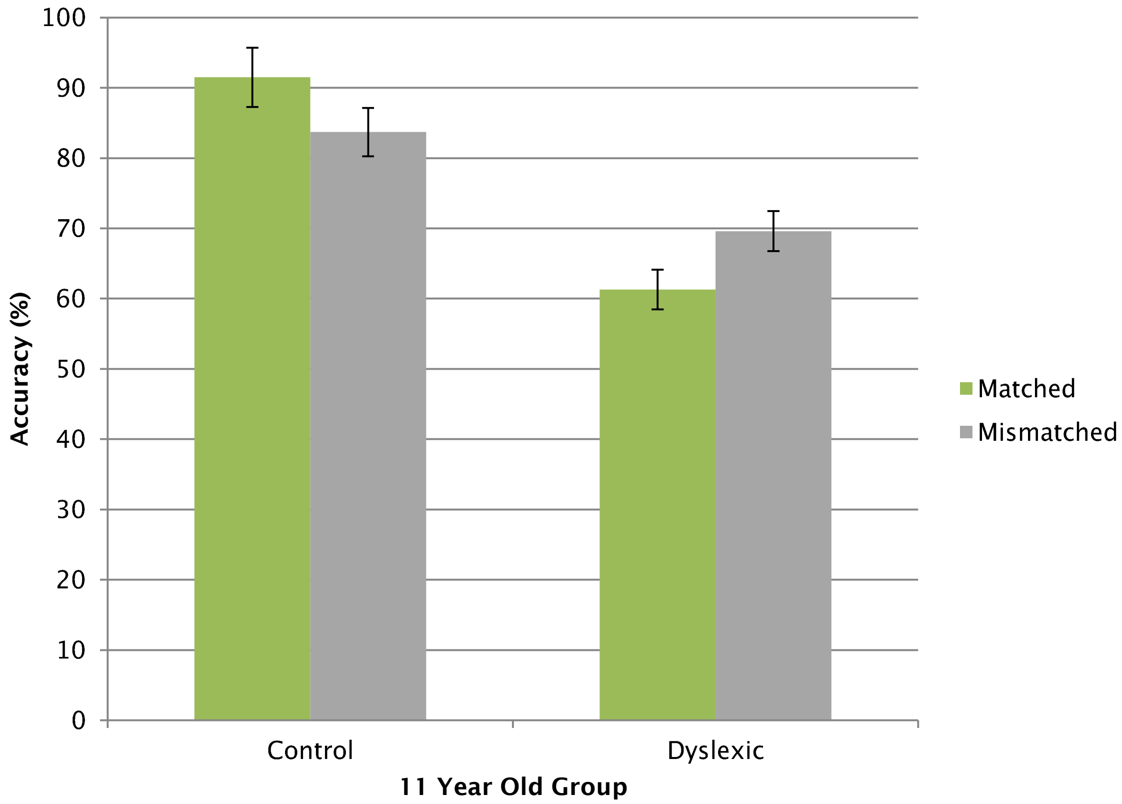

Figure 3.13: Interaction Between Group by Correctness for 11 Year Old Age Group

3.5.3.3 Analysis for14 Year Olds Only

Separating by age a three-way ANOVA for Group by Age by Complexity was conducted. Surprisingly, the main effect of Group was non-significant, F(1,38) = 3.6, p=.065 . However, the equivalent examination of Correctness by Group for the 14 year olds revealed no equivalent interaction ($F(1,38) = .027$, $p=.87$) for these two factors compared to that seen in 11 year olds above. No other analyses were significant. Please see Figure 3.14 for Group by Correctness results for 14 year olds. The descriptives table of mean accuracy is presented in Appendix B.11.

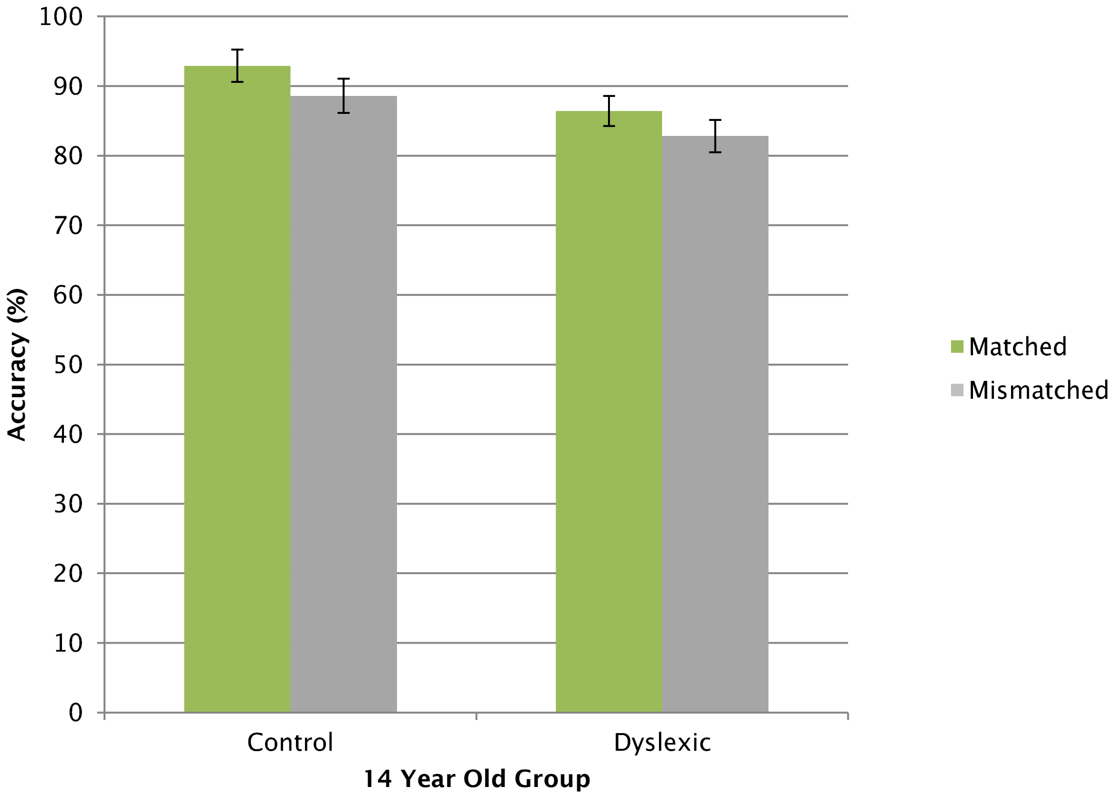

Figure 3.14: Interaction Between Group by Correctness for 14 Year Old Age Group

3.5.4 Second of Two 4-way Interactions

Returning to the five-way mixed ANOVA presented in section 3.5.3, Group (dyslexic and control), Age (11 year old and 14 year old) by Quartile (4 quartiles of the clock) and Correctness (correct and incorrect response) for the Intermediate and Complex clock faces only.

There was a four-way interaction between Correctness by Complexity by Age by Group, $F(1,76) = 3.97$, $p=.05$. To explore this, we split out the Correctness factor to look at Matched and Mismatched Faces separately.

3.5.4.1 Matched Clock Faces Only

For the three-way ANOVA, Complexity by Age by Group, there was a three-way interaction of Complexity by Group by Age, $F(1,76) = 5.04$, $p=.028$. This result in turn was split out to examine the 11 and 14 year groups separately.

3.5.4.2 Eleven Year Olds Only

The Complexity by Group interaction was significant, $F(1,38) = 10.42$, $p=.003$ (see Figure 3.15). Planned pairwise *t*-tests revealed that for dyslexic 11 year olds they performed better on the intermediate faces (mean =72.5; SD = 2.3) compared with complex faces (mean = 61.3; SD = 2.8), $t(\text{df} = 19) = 3.01$, $p=.007$. By contrast control 11 year olds showed no difference in performance between level of complexity of faces, $t(\text{df} = 19) = 1.34$, $p=.197$. The descriptives table of mean accuracy is presented in Appendix B.12.

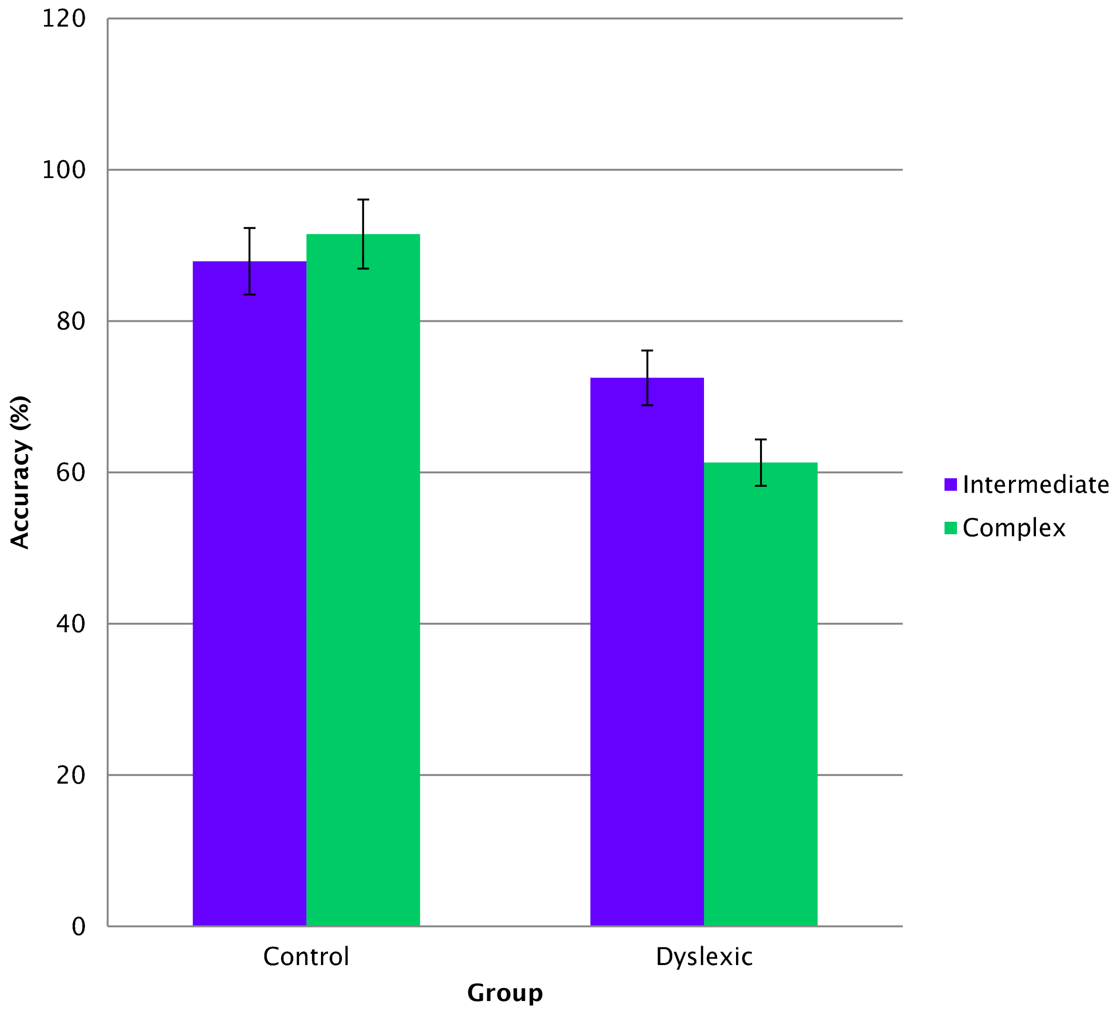

Figure 3.15: Interaction Between Group by Complexity for 11 Year Old Age Group - Matched Clock Faces Only

3.5.4.3 Fourteen Year Olds Only

For the 14 year olds there was no equivalent interaction of Complexity by Group, $F(1, 38) = .001$, $p=.998$ nor was there a main effect of Complexity, $F(1,38) = .903$, $p=.35$. There was, however, a marginal main effect of Group, $F(1,38) = 3.9$, $p=.055$ with controls performing better overall for matched faces (mean = 91.8; SE = 2.3) compared with dyslexics (mean = 85.3; SE = 2.3).

3.5.4.4 Mismatched Faces

For the three-way ANOVA, Complexity by Age by Group for mismatched clock faces only, there was a main effect of Complexity, $F(1,76) = 19.4$, $p=.001$ with intermediate times surprisingly performed less well (mean = 74.0; SE = 2.0) than complex times (mean = 81.2; SE = 1.8). There was also a main effect of Age, $F(1,76) = 6.77$, $p=.011$ (11 year old mean = 73.2; SE = 2.4 versus 14 year old mean = 82.0; SE = 2.4); finally there was a main effect of Group with controls performing at a higher level (mean = 82.8; SE = 2.4) than dyslexics (mean = 72.4; SE = 2.4), $F(1,76) = 9.62$, $p=.003$. There were no interactions (all p's >.1).

3.5.5 Accuracy Summary – Research Questions Answered

This summary presents the accuracy findings based on the two between participant factors of Group (dyslexic and control) and Age (seven year old, 11 year old and 14 year old). It also summarises the accuracy findings based on the three within participant factors, which are Quartile (4 quartiles of the clock), Complexity (simple, intermediate and complex) and Correctness (matched and mismatched response).

When performing the operation of accurately recognising clock times will dyslexics be less accurate than non-dyslexics?

Generally the answer to this is "yes". There is a main effect of within factors of Quartile and Complexity and main effect of between factors of Group and Age. The various interactions between these factors suggest that there is a -different pattern of accuracy for the dyslexic and control groups.

Will younger dyslexics be less accurate than older dyslexics?

The answer to this is "yes". When comparing the two older age groups, the mean accuracy does differ between the 11 year old and 14 year old dyslexic cohorts. Accuracy improves with age.

3.5.5.1 Group (Dyslexic and Control Groups)

For the accuracy output there was a main effect of Group across the three ages. The findings showed that the dyslexic and control seven year olds were less accurate than the 11 and 14 year olds on simple clock faces only. Analysis of the interactions between the two older groups led to the emergence of a two-way interaction for the 11 year old group of Correctness by Group, which was not evident with the 14 year old age group for the complex clock faces only. Separating out the Group and comparing them for the Correctness factor, that is, matched versus mismatched times, the 11 year old control participants were more accurate on complex matched clock faces than mismatched clock faces. In contrast, the 11 year old dyslexic participants were more accurate on the complex mismatched clock faces than matched clock faces. Such a pattern for the dyslexic cohort was not evident in the 14 year old results. Further, the dyslexic 11 year olds were more accurate on intermediate clock faces compared with complex clock faces, which was not apparent for the 11 year old control group. In fact, the 11 year old control participants showed little difference across the complexity levels for matched clock faces. The 14 year old control group was marginally more accurate on matched clock faces than the 14 year old dyslexic group. Where there are these interactions, the dyslexic participants' performance differ from that of the controls in accuracy for the younger 11 year old group, and for the complexity and correctness factors, compared with the 14 year old group.

There is compelling evidence to suggest that the dyslexic group are consistently less accurate with their answers than the control group.

3.5.5.2 Age Effect

It was found that there was a main effect of Age for the accuracy responses of the seven year old versus the 11 year old groups, the seven year old versus the 14 year old groups, and the 11 year old versus the 14 year old groups. Seven year olds were approximately half as accurate as 11 year olds, who were marginally less accurate than the 14 year olds for the simple clock faces.

There was a main effect of Age between all three age groups. The 11 year old controls showed little performance accuracy differences between any of the complexities. In contrast, however, the dyslexic 11 year olds were more accurate on intermediate matched clock faces compared with the complex matched clock faces. Furthermore, the 14 year old controls performed marginally more accurately on the matched clock faces than the 14 year old dyslexic participants. For mismatched clock faces, however, 14 year old participants performed better than the 11 year old participants. This performance improvement with age in accuracy is expected, as skills mature with age.

3.5.5.3 Quartile Effect

For mismatched faces, quartile 1 was more accurate than quartile 3, quartile 4 and quartile 2 (in order of accuracy). For matched clock times, quartile 2 was more accurate than quartile 1, quartile 4 and quartile 3 (in order of accuracy).

Overall, the weight of comparisons considering the relative performance of participants across each of the four quartiles, such that it exists, re-confirms the pattern observed in the reaction times reported later, suggesting quartile 1 items were favoured.

3.5.5.4 Complexity Factor

The accuracy of the control group was found to be better than the dyslexic group for intermediate and complex clock face times. The control 11 year olds showed no significant difference between the complexity types though, in contrast, the 11 year old dyslexic group did show greater accuracy with intermediate clock times than complex times. In addition, the complex times were approximately 30% less accurate for the dyslexic 11 year olds compared with their control counterparts. This contrasted with the intermediate times which were approximately 15% less accurate for the dyslexic cohort compared with the control cohort. For the 14 year old participants there was no equivalent interaction of Complexity by Group.

3.5.5.5 Correctness Factor

Analysis of the accuracy for the matched and mismatched clock faces shows that for both correctness levels the 14 year old control participants were more accurate than their dyslexic counterparts. The 14 year old controls performed marginally more accurately on the matched clock faces than the mismatched times, which was similar to the accuracy pattern of the 14 year old dyslexic participants. The 11 year old controls performed closely to that of the 14 year old controls for both correctness factors, whereas, the dyslexic groups did not. This suggests that the 11 year old controls have largely mastered the skill of answering clock times accurately. The level of improvement for the controls aged 11 and the controls aged 14 is approximately 1.4% - 4.9%, 8% for both correctness levels. In contrast, the dyslexics improve by approximately 20%, 13-25% (matched-mismatched) from 11 to 14 years.

The 11 year old dyslexic group were approximately 14% less accurate on mismatched complex times than their control counterparts. For complex matched clock faces this difference between the dyslexic and control group was approximately 30%, with the control group outperforming their dyslexic counterparts.

It is clear from the results that the dyslexic participants' performance is less accurate than their control counterparts and remains so into their mid-teens. It is also clear that with maturation, the dyslexic participants improve in accuracy so that they are narrowing the accuracy gap with their control counterparts, as compared to when they were younger. Also, they appear to be able to tackle the more complex questions more accurately at this older age.

3.6 Results - Reaction Time

The experiment was designed to measure the time taken to respond to visually presented clock stimuli shown on a computer for time related questions. Reaction time in this experiment is defined as the time taken to respond to these stimuli. Measured in seconds, by depressing the correct response key on the keyboard, reaction time represents the time between presentation onset of the time stimuli and the participant's subsequent response. These results represent this measurement for the accurate responses only.

When looking at the operation of recognising clock times at speed in this time comparison experiment, the following two questions are examined:

3. *When performing the operation of recognising clock times at speed will dyslexics need more time than non-dyslexics to answer questions accurately?*
4. *Will younger dyslexics be slower than older dyslexics in their response time?*

Table 3.8 presents a summary of the reaction time means for Quartile, Group and Age.

Table 3.8: Mean Reaction Time for Quartiles by Group and Age

	Group	Age	Mean (seconds)	Std. Deviation	N
Quartile 1	Control	7 year old	7.050	3.441	20
		11 year old	5.305	2.083	20
		14 year old	3.382	9.12	20
		Total	5.246	2.785	60
	Dyslexic	7 year old	5.440	2.809	20
		11 year old	5.778	2.436	20
		14 year old	5.038	1.484	20
		Total	5.419	2.292	60
Quartile 2	Control	7 year old	9.948	5.964	20
		11 year old	6.224	1.945	20
		14 year old	4.105	1.344	20
		Total	6.759	4.380	60
	Dyslexic	7 year old	9.824	8.594	20
		11 year old	10.323	5.354	20
		14 year old	8.639	1.861	20
		Total	9.595	5.885	60
Quartile 3	Control	7 year old	8.617	4.642	20
		11 year old	6.285	1.750	20
		14 year old	3.850	8.64	20
		Total	6.251	3.467	60
	Dyslexic	7 year old	6.764	4.243	20
		11 year old	8.170	2.891	20
		14 year old	7.509	2.578	20
		Total	7.481	3.311	60
Quartile 4	Control	7 year old	9.389	5.447	20
		11 year old	6.392	1.903	20
		14 year old	4.369	1.225	20
		Total	6.717	3.941	60
	Dyslexic	7 year old	6.348	4.053	20
		11 year old	8.422	3.854	20
		14 year old	7.363	2.385	20
		Total	7.378	3.554	60

3.6.1 Reaction Time Analysis for Seven Year Old Group Only

In the earlier accuracy results, in the five-way ANOVA, there was a main effect of Age (see 3.5.1) which resulted in separating the seven year olds from the 11 and 14 year olds for the intermediate and complex items. In addition, all age groups were analysed for the simple clock faces only. For the purposes of consistency, the reaction time data will be treated in the same manner. The unique characteristics of the seven year olds is further illustrated if we examine this cohort's reaction time performance for only the simple clock faces, which were selected to be at their age appropriate level according to the National Curriculum. The reaction times (see Appendix C.1) for the seven year old control participants (mean = 9.28 seconds) were slower than that of the dyslexic participants (mean = 6.74 seconds). An independent sample t-test (Appendix C.2), $t(38) = 1.86$, $p=.07$ showed that although there was no significant difference between the seven year old dyslexic and control groups, the direction of the reaction times is counter to what one would predict. Indeed this pattern is counter to the reaction time results for the other two age groups that show dyslexic reaction times are slower than their age matched controls. It would appear that the seven year old participants responded quite differently in comparison with the other two age groups.

Taking accuracy into account as reported earlier in this chapter, it would appear that there was a trade-off between speed and accuracy for seven year olds. The reaction time means are based on an accuracy score of only 36% for the dyslexic group compared with 75% for the age matched control group. Clearly, from these findings, there is a large discrepancy between accuracy for the two seven year old groups that may explain the quicker reaction time advantage for the dyslexics at age 7. It is surmised that a "floor effect" artefact may explain these findings with young dyslexic participants attempting and answering easy questions rapidly but at less than chance levels).

Splitting out the seven year old group from the other two age group cohorts and examining the simple clock faces only for this age group is therefore justified for two main reasons:

- The young age group participants are unlikely to have been exposed to the more difficult clock times presented in the experiment.
- The dyslexic group may have been overwhelmed by the demands of the challenge, particularly for the more complex clock faces, and resorted to a different approach such as "passing" or "guessing".

3.6.2 *Eleven and Fourteen Year Olds Analysis*

The analysis employed was a five-way mixed ANOVA, Group (dyslexic and control), and Age (11 year old and 14 year old) by Quartile (4 quartiles of the clock) and Correctness (matched and mismatched) for Complexity (simple, intermediate and complex) of clock faces.

There was found to be a main effect of Quartile (means: Q1 5.3 seconds; Q2 6.5s; Q3 6.7s and Q4 6.6s), $F(2.60, 197.6) = 22.36$, p=.001 (Greenhouse-Geisser corrected); and Complexity (means = Simple 5.6s; Intermediate 6.0s and Complex 7.2s), $F(1.79,135.8) = 30.19$, p=.001. There was a between subjects main effect of Group, $F(1,76) = 29.43$, p=.001 and also Age, $F(1,76) = 8.73$, p=.004. Figure 3.16 illustrates the mean reaction time performance for Group by Age (means = 11 year olds – control 6.1s; dyslexic 7.9s; 14 year olds – control 3.8s; dyslexic 7.2s). It can clearly be seen that the 14 year old dyslexics perform worse than the 14 year old controls and that the 11 year old control group performance was more similar to the 11 year old dyslexics. The descriptives table of mean reaction time is presented in Appendix C.3.

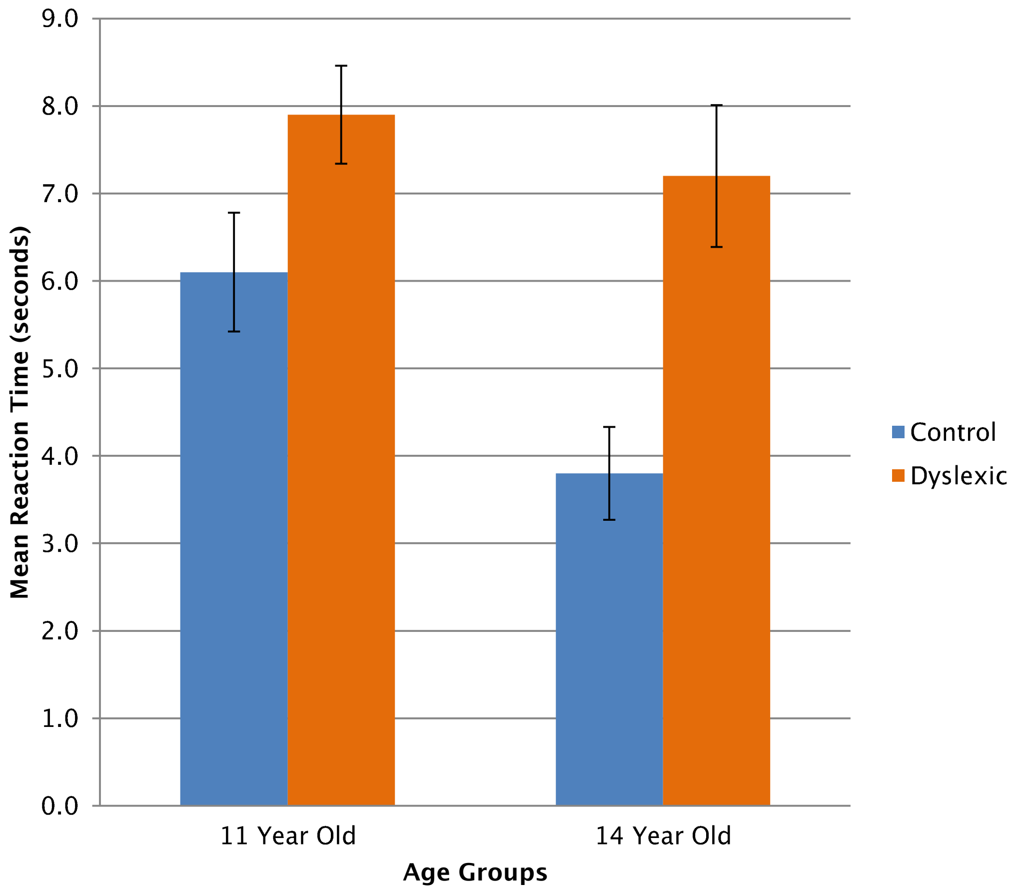

Figure 3.16: Mean Reaction Time for Group by Age

There was a two-way interaction of Quartile by Complexity, $F(3.83,291) = 9.54$, $p=.001$ (Greenhouse-Geisser corrected); Complexity by Correctness, $F(1.68,127.9) = 7.5$, $p=.002$ (GG); and Quartile by Correctness, $F(2.73,202.2) = 3.81$, $p=.013$. A three-way interaction of Quartile by Complexity by Correctness, $F(3.68,279.5) = 10.1$, $p=.001$ (GG) was also found.

Following this three-way interaction it was decided that this complex result would be further investigated by splitting the correctness factor (matched versus mismatched) clock face problems.

3.6.2.1 Matched Clock Face Analysis

Separating by Correctness a four-way ANOVA for Group by Age by Quartile by Complexity was conducted. There was a main effect of Quartile, $F(2.30,174.7) = 23.55$, $p=.001$ (Greenhouse-Geisser corrected) and there was a main effect of Group, $F(1,76) = 27.3$, $p=.001$ (GG) with the controls' reaction time performance (mean = 4.76 seconds; Standard Error = 0.382) being quicker than the dyslexic performance (mean = 7.58 seconds; SE = 0.382); and a main effect of Age $F(1,76) = 6.78$, $p=.011$. There was also a main effect of Complexity, $F(1.76, 133.8) = 23.63$, $p=.001$ and a two-way interaction of Quartile by Complexity, $F(3.20,243.1) = 10.68$, $p=.001$ (GG). The interaction is explored below by comparing across quartiles for each complexity condition separately. Figure 3.17 shows this interaction. The descriptives table of mean reaction time is presented in Appendix C.4.

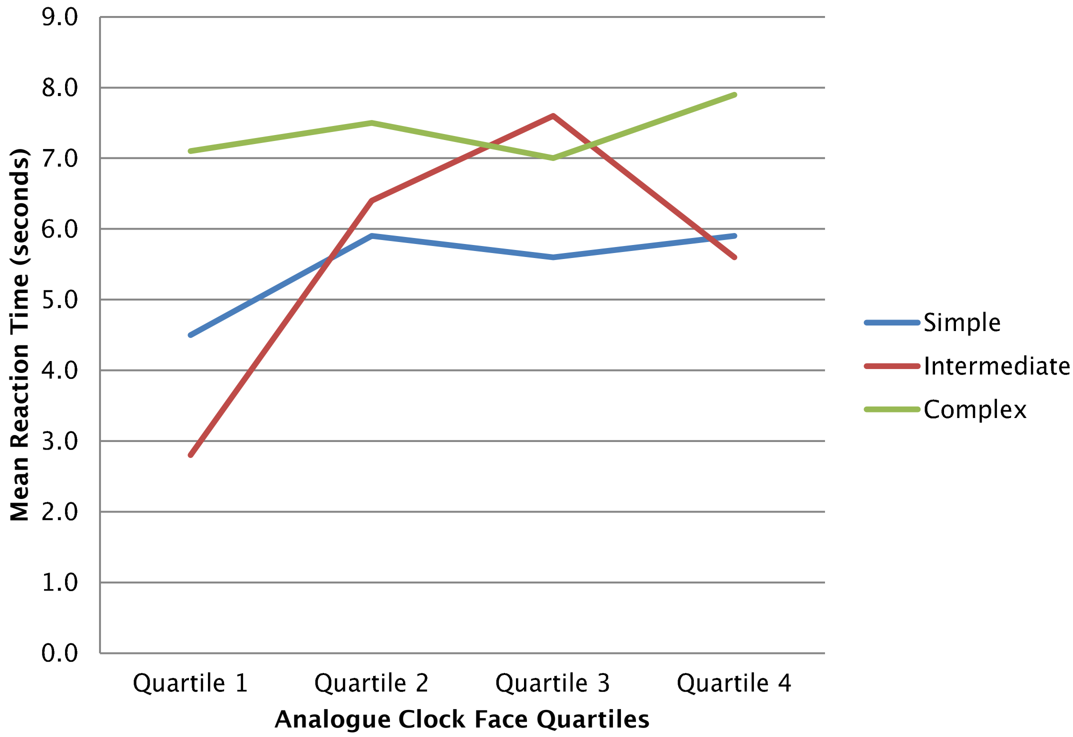

Figure 3.17: Mean Reaction Time for Quartile by Complexity

3.6.2.1.1 Simple Clock Faces Only

Separating by Complexity a four-way ANOVA for Group by Age by Quartile by Correctness was conducted. Examining simple clock faces only there was a main effect of Quartile, $F(3,79) = 5.3$, $p=.001$. Follow up Tukey (Least Significant Difference Tests) revealed that quartile 1 was significantly faster for participants than all other quartiles (all ps<.005). No other quartiles differed.

3.6.2.1.2 Intermediate Clock Faces Only

Separating by Complexity a four-way ANOVA for Group by Age by Quartile by Correctness was conducted. Examining intermediate clock faces only there was a main effect of Quartile, $F(1.60,126.6) = 21.45$, $p=.001$ (GG). Follow up Tukey (Least Significant Difference Tests) revealed that quartile 1 was again significantly faster for participants than all other quartiles (all ps <.001). In addition, quartile 3 was significantly slower than quartile 4 ($p=.022$). No other quartiles differed.

3.6.2.1.3 Complex Clock Faces Only

Separating by Complexity a four-way ANOVA for Group by Age by Quartile by Correctness was conducted. For complex clock faces only there was a main effect of Quartile, $F(2.71,213.7) = 4.2$, $p=.008$ (GG). Follow up Tukey (Least Significant Difference Tests) revealed that quartile 1 was significantly faster for participants than quartile 4 (*p*=.015); quartile 2 was slower than quartile 3 (*p*=.03) and quartile 3 was faster than quartile 4 (*p*=.005). No other quartiles differed.

3.6.2.2 Mismatched Clock Face Analysis

Separating by Correctness a four-way ANOVA for Group by Age by Quartile by Complexity was conducted. There was a main effect of Quartile, $F(2.53,192.2) = 5.41$, $p=.003$ (GG), and there was a main effect of Group, $F(1,76) = 26.3$, $p=.001$ with the control reaction time performance (mean = 5.2 seconds; SE = 0.34) being quicker than the dyslexic performance (mean = 7.6 seconds; SE = 0.34). There was also a main effect of Age, $F(1,76) = 9.38$, $p=.003$. There was a main effect of Complexity, $F(1.73,131.8) = 20.6$, $p=.001$; a two-way interaction between Quartile by Complexity, $F(4.37,332.7) = 8.67$, $p=.001$ and a three-way interaction between Quartile by Complexity by Group, $F(4.37,332.4) = 1.11$ $p=.041$ (GG).

It was decided to separate out this three-way interaction by Complexity (simple, intermediate and complex) for mismatched faces to enable further investigation of the complexity effects. Figure 3.18 illustrates the three-way interaction between Group by Quartile by Complexity (it is illustrated split by Group for clarity only). The descriptives table of mean reaction time is presented in Appendix C.5.

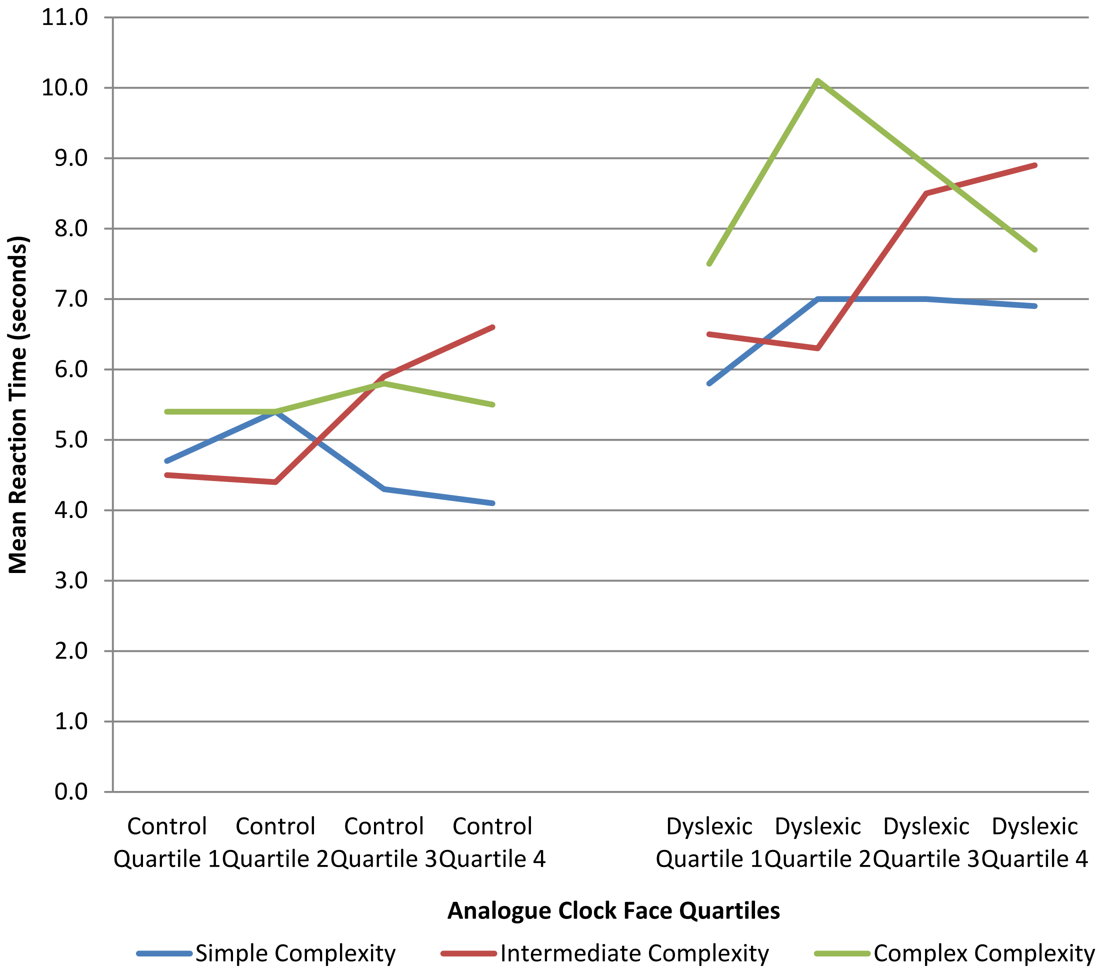

Figure 3.18: Mismatched Clock Faces Only: Three-way Interaction – Group by Quartile by Complexity

Between the dyslexic and control groups the simple times converge toward quartile 2 then sharply diverge across quartile 3 and 4, with a reaction time approaching 2 seconds faster for the control group. It can be observed too, that the control and dyslexic intermediate reaction time responses are very close to mirroring one another across the four quartiles, with the dyslexic performance consistently ≈ 1.5 seconds slower. In contrast, the complex time responses are very different in shape between the Groups. Indeed, it can be seen that the dyslexic cohort responses to complex times more closely mimic in shape the responses of the control cohort's simple response times across the four quartiles.

3.6.2.3 Simple Mismatched Clock Face Analysis

Separating by Correctness and Complexity a three-way ANOVA for Group by Age by Quartile was conducted. There was a between subjects main effect of Group, $F(1,76) = 17.55$, $p=.001$ with the control group's reaction time performance (mean = 4.6

seconds; SE = .345) being quicker than the dyslexic performance (mean = 6.65 seconds; SE = .345). There was also an Age effect, $F(1,76) = 10.62$, $p=.002$ with the 14 year age group reaction time (mean = 4.83 seconds; SE = .345) being faster than the 11 year age group (mean = 6.44 seconds; SE =.345).

There was a marginal two-way interaction of Quartile by Group, $F(2.52,191.9) = 2.79$, $p=.051$ (GG).

This two-way interaction was explored by examining control and dyslexic conditions separately for each quartile. For control participants there was a main effect of Quartile, $F(2.46,96.1) = 4.69$, $p=.007$. Pairwise Tukey (LSD) revealed quartile 1 was faster than quartile 4 ($p=.042$); quartile 2 was slower than quartile 3 ($p=.011$); and quartile 2 was slower than quartile 4 ($p=.009$). In contrast for the dyslexics there was no main effect of Quartile, $F(2.32,90.5) = 1.71$, $p=.181$. Figure 3.19 illustrates the two-way interaction between Quartile by Group. The descriptives table of mean reaction time is presented in Appendix C.6.

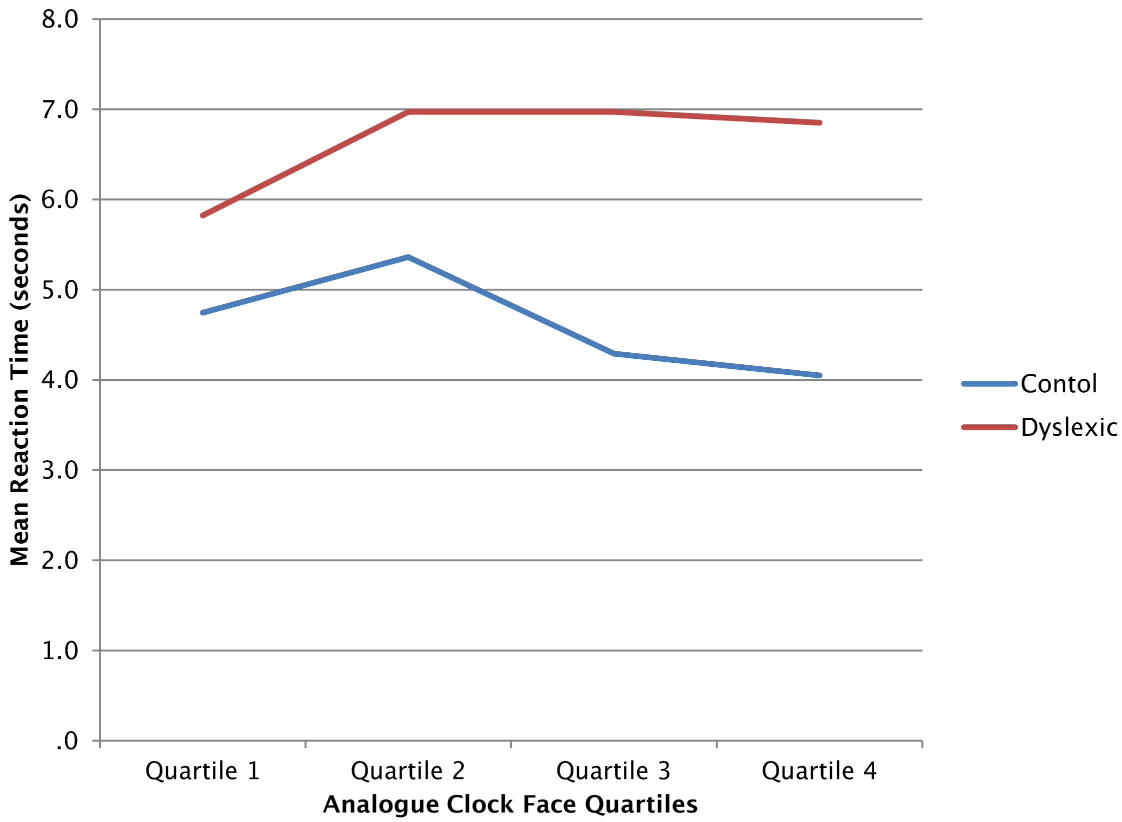

Figure 3.19: Simple Mismatched Clock Faces Only: Marginal Two-way Interaction of Quartile by Group

Pairwise *t*-tests (with an adjusted alpha level of $p<0.0125$) comparing dyslexics with controls at each quartile separately revealed no difference for quartile 1, $t(df= 78) = 1.82$, $p=.073$ or quartile 2, $t(78) = 1.75$, $p=.084$. However, quartile 3, $t(78) = 4.66$, $p=.001$ and quartile 4, $t(78) = 4.9$, $p=.001$ differed significantly for Group.

3.6.2.4 Intermediate Mismatched Clock Face Analysis

Separating by Correctness and Complexity a three-way ANOVA for Group by Age by Quartile was conducted. There was a between subjects main effect of Group, $F(1,76) = 16.36$, p =.001 with the control group's reaction time performance (mean = 5.35 seconds; SE = .385) being quicker than the dyslexic performance (mean = 7.56 seconds; SE = .385). There was also an Age effect, $F(1,76) = 6.36$, $p=.014$ with the 14 year old group reaction time (mean = 5.77 seconds; SE = .385) being faster than the 11 year old group (mean = 7.14 seconds; SE = .385). There was a main effect of Quartile, $F(2.56,194.7) = 9.96$, $p=.001$ (GG).

When examining the quartile main effect it was observed using Tukey pairwise comparisons that there was a significant difference between quartile 1 which was faster than quartile 3 ($p=.001$), and quartile 1 which was faster than quartile 4 ($p=.001$). In addition, there was a significant difference in performance between quartile 2 and quartile 3 ($p=.001$), and quartile 2 and quartile 4 ($p=.001$). Quartile 2 was faster in both cases. Figure 3.20 illustrates the participants' performance. The descriptives table of mean reaction time is presented in Appendix C.7.

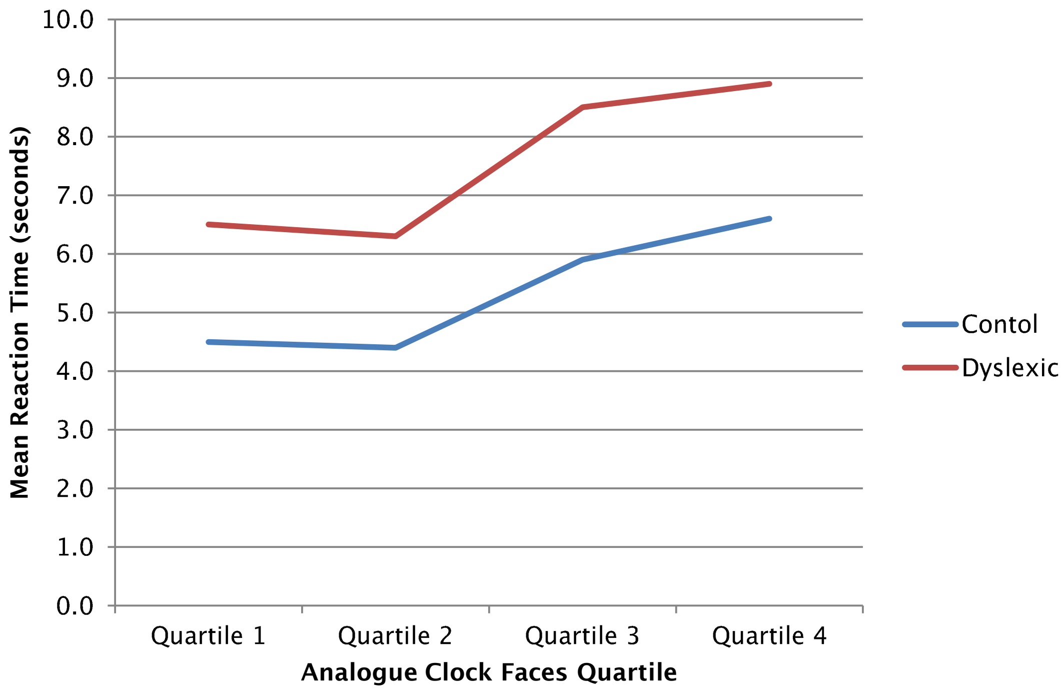

Figure 3.20: Intermediate Mismatched Clock Faces Only: Quartile by Group for 11 and 14 Year Olds

3.6.2.5 Complex Mismatched Clock Face Analysis

Separating by Correctness and Complexity a three-way ANOVA for Group by Age by Quartile was conducted. There was a between subjects main effect of Group, $F(1,76) = 28.03$, $p=.001$ with the control group's reaction time performance (mean = 5.5 seconds; SE =.409) being quicker than the dyslexic performance (mean = 8.56 seconds; SE = .409). There was also an Age effect, $F(1,76) = 5.86$, $p=.018$ with the 14 year old age group reaction time (mean = 6.33 seconds; SE = .409) being faster than the 11 year age group (mean = 7.73 seconds; SE = .409).

There was a main effect of Quartile, $F(2,152.3) = 6.534$, $p=.002$ and a two-way interaction of Quartile by Group, $F(2,152.3) = 6.14$, $p=.003$ (GG).

Further, when examining this two-way interaction for the control group, it is observed that for the complex mismatched clock faces between quartile 1 and quartile 4 there appears to be fairly linear reaction time speed, with no quartile effect, $F(3,117) = .933$, $p=.427$. In contrast, the equivalent comparison for the dyslexic group only for the 4 quartiles revealed the source of the quartile effect for the preceding two-way interaction, $F(1.82,70.9) = 7.43$, $p=.002$ (GG). Pairwise comparisons across the four quartiles for dyslexic participants revealed that quartile 2 and 3 were significantly slower than quartile 1 (all ps<.005) and also quartile 4 (all ps<.05). Quartile 2 and 3 did not significantly differ. Figure 3.21 illustrates the two-way interaction between Group by Quartile. The descriptives table of mean reaction time is presented in Appendix C.8.

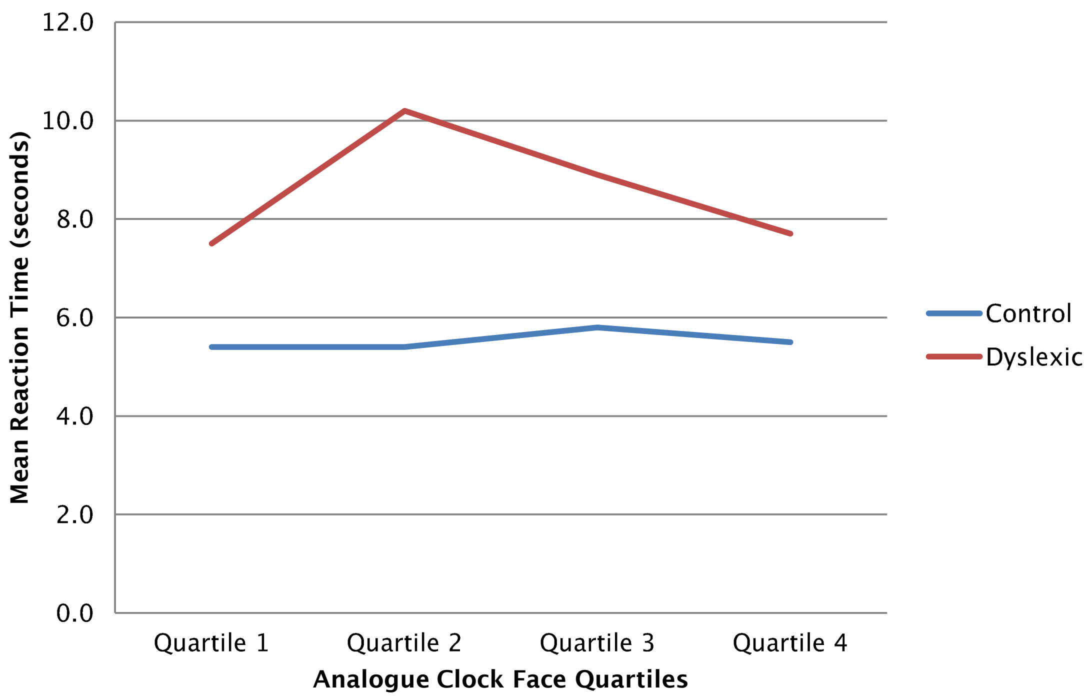

Figure 3.21: Complex Mismatched Clock Faces Only: Group by Quartile

When examining Figure 3.21, the reaction times for the control group are much more linear than for the dyslexic participants. It should be noted that the reaction times between the two quartiles closest to the target digital time comparison, set in the corner of the clock, namely quartile 2 and quartile 3, were slower than the other quartiles for the dyslexic group.

3.6.3 Reaction Time Summary – Research Questions Answered

When performing the operation of recognising clock times at speed will dyslexics need more time than non-dyslexics to answer questions accurately?

The answer to this is "yes" as indicated by the main effect of Group. This is complicated, however, by a complex series of main effects of within factors: Quartile and Complexity and a main effect of between factors with Age. The various interactions between these factors suggest that dyslexic participants take longer to respond to the time stimulus.

Will younger dyslexics be slower than older dyslexics in their response time?

The answer to this is "yes". The mean reaction times of the two older dyslexic groups do differ, with the 11 year old participants being generally slower in response time than the 14 year old participants.

This summary presents the reaction time findings based on the two between participant factors of Group (dyslexic and control) and Age (seven year old, 11 year old and 14 year old). It also summarises the reaction time findings based on the three within participant factors that were Quartile (4 quartiles of the clock), Complexity (simple, intermediate and complex) and Correctness (matched and mismatched response).

3.6.3.1 Group (Dyslexic and Control Groups)

The analysis of the reaction time data shows that there is a main effect of Group. The dyslexic participants' reaction time was found to be slower than their control counterparts. There were, however, interactions with Quartile, Complexity and Correctness influencing the outcomes. As described earlier in this chapter, reaction time for the seven year olds was not examined any further. The reaction time for the 11 and 14 year olds did reveal consistently that for both Correctness factors (matched and mismatched), and intermediate and complex times, the dyslexic participants' reaction time to the stimuli were slower than their control counterparts. The dyslexic 11 year olds were $\approx$ 1 second slower than their age matched controls. This reaction time "gap" increased to $\approx$ 2.5 seconds between the dyslexic and control 14 year olds. Further, the 14 year old dyslexic participants were only marginally quicker (≈ 0.2 seconds) than the 11 year old control group.

There is compelling evidence to suggest that the dyslexic participants consistently present a slower reaction time compared to the controls with their answers. The author proposes, therefore, that dyslexics require additional time to process the information before them and that their accuracy is reliant on this additional processing time.

3.6.3.2 Age Effect

For reaction time, there was a main effect of Age found in both the matched and mismatched correctness factors. The 11 and 14 year old control group outperformed the dyslexic 11 and 14 year old groups when identifying matched and mismatched times throughout the various complexity levels. In addition, it would appear from these results that reaction time improves with age more for the control group (≈43%) compared with the dyslexic group (≈15%) confirming that for the dyslexic participants, time telling remains more challenging. It is proposed that there is a different pattern of speed-accuracy trade-off for controls and dyslexic children. This is explored subsequently in Chapter 6.

3.6.3.3 Quartile Effect

The Quartile by Complexity interaction that emerged in the reaction time data for matched and mismatched clock times, and the Quartile by Correctness interaction in the accuracy data, helps to provide compelling evidence that quartile 1 items are faster to process than all other quartiles. It must be noted; however, that this result applies to both dyslexic and control groups. Interactions involving the quartile factor reveal a pattern most strongly seen in intermediate matched clock faces, that quartile 1 is quicker than all other quartiles. For complex matched clock faces, quartile 1 was the fastest quartile and significantly faster than quartile 4. For mismatched faces of intermediate complexity, quartile 1 was fastest and faster than quartile 2, quartile 3 and quartile 4; for mismatched complex clock times, quartile 1 was again fastest and faster than quartile 2 and quartile 3. Overall, the weight of comparisons considering the relative performance of participants across each of the four quartiles, such that it exists, reveals a pattern suggesting quartile 1 items were favoured.

A counter argument that quartile 1 advantage merely reflects the proximity between quartile 1 and the digital clock in the comparison phase can be strongly challenged by the evidence. There was little evidence of quartile 2, which was even more proximate, having improved performance except in the one example stated above.

Indeed, there were many instances in which quartile 2 was inferior to quartile 3 and quartile 4 (less proximate). For example, for complex times, matched and mismatched times were slower for quartile 2 than quartile 3. The only exception to this being for mismatched complex times in which quartile 2 and quartile 1 were faster than quartile 3 and quartile 4.

3.6.3.3.1 Hemispherical Issue and Left Neglect

A quartile analysis was undertaken to determine if there was any observable hemispherical issue and to explore if signs of left neglect were evident between quartile 2 and quartile 3. In addition, the quartile analysis would determine signs of reaction time delay, possibly signifying a different strategy in tackling those times furthest from quartile 2, namely quartile 4.

Preparation for this analysis was made by extracting those analogue times which are located in each of the four quartiles where both the hour and minute hands lie within the quartile. This differed from the original analysis where the hour hand only dictated the quartile position.

Table 3.9 illustrates the analogue clock times representing the new analysis criteria. It can be observed that the times are predominantly complex times (52%), with a spread of intermediate (16%) and simple times (32%) presented.

Table 3.9: Analogue Clock Times in the Four Quartiles

Quartile 1 12:00-02:15 00:00-14:15	Quartile 2 03:16-05:30 15:16-17:30	Quartile 3 06:31-08:45 18:31-20:45	Quartile 4 09:46-11:59 21:46-23:59
Q1_C_T_0008_24	Q2_S_W_330_12	Q3_C_T_1938_24	Q4_C_T_2146_24
Q1_C_W_108_12	Q2_C_W_321_12	Q3_C_T_633_12	Q4_C_T_2356_24
Q1_C_W_1503_24	Q2_I_T_1520_24	Q3_C_T_739_12	Q4_C_T_2357_24
Q1_C_W_213_12	Q2_C_T_1619_24	Q3_C_T_745_12	Q4_C_T_949_12
Q1_I_T_1405_24	Q2_C_T_1723_24	Q3_C_W_1831_24	Q4_C_T_959_12
Q1_I_W_0010_24	Q2_C_T_418_12	Q3_C_W_637_12	Q4_C_W_1054_12
Q1_I_W_105_12	Q2_C_W_1626_24	Q3_I_W_640_12	Q4_C_W_2357_24
Q1_I_W_1310_24	Q2_C_W_1727_24	Q3_S_T_830_12	Q4_C_W2_1149_12
Q1_S_T_115_12	Q2_S_T_1715_24	Q3_S_W_1830_24	Q4_C_W1_1149_12
Q1_S_T_1300_24	Q2_S_T_515_12	Q3_S_W_2045_24	Q4_C_T_1149_12
Q1_S_T_200_12	Q2_S_T_1730_24		Q4_I_T_2255_24
Q1_S_W_1315_24			Q4_I_W_2350_24
Q1_S_W_1415_24			Q4_S_T_1045_12
			Q4_S_T_2200_24
			Q4_S_T_2345_24
			Q4_S_W_1100_12
Total	Total	Total	Total
13	11	10	16

Key: Q2_C_W_1626_24 (Quartile 2, Complex, Wrong, Comparative Analogue Time Displayed, 24 hour time).

A MANOVA analysis comparing quartile 2 and quartile 3 for the Group revealed a significant interaction between Group and Quartile $F(2,75)=24.47$ $p=.001$, though this was counter to the anticipated left latency theory proposed. For Group, the responses are quicker for quartile 3 (dyslexic mean for 11 year olds = 8.170 seconds) when compared with quartile 2 (mean= 10.323). The 14 year old dyslexics, in contrast, are faster than the dyslexic 11 year olds, as has already been reported. They too, present a reaction time similar to the 11 year old group, performing faster on quartile 3 (mean =7.509 seconds) than quartile 2 (mean = 8.639 seconds). The control group performance is marginally the same for the two quartiles; the 11 year olds performing the same for both quartiles and the 14 year old controls performing faster in quartile 3 (mean = 3.85 seconds) than in quartile 2 (mean = 4.11 seconds).

For both dyslexic and control groups to perform in this way presents a curious result, possibly suggesting that the processes both cohorts adopt may be similar in some cases where a known anchor point may be used, such as quarter past the hour or half past the hour. The dyslexic cohort might rely more on the o'clock anchor point to answer the quartile 2 questions and the half-past anchor point to answer quartile 3 questions. This would shorten the distance to compute the question for quartile 3 and thus make the times quicker to respond to. The control cohort may adopt similar strategies but also gain the advantage of acquiring quicker fact retrieval.

To examine signs of an anchor point strategy further, an investigation through analysis of quartile 4 compared with the quartile 2 was implemented. This revealed that the dyslexic performance for quartile 4 was marginally the same for both 11 (mean = 8.42 seconds) and 14 year old (mean = 7.36 seconds) participants as that of their mean performance in quartile 3, as reported earlier.

Both these sets of results suggest that there is no sign of a left latency deficit to report, though it does appear that differing strategies may have been adopted by both groups in tackling these questions, and that it may be that anchor points play a pivotal role for the dyslexic group, with the o'clock and half past as important reference points.

3.6.3.4 Complexity

Complexity refers to the simple, intermediate and complex times presented. The simple times denote times on the analogue clock set at the hour, quarter after, half after and quarter to the hour. Intermediate denotes the times set at the five minute interval markers, and complex denotes times at the single minute markers. The main effect of Complexity emerged in the reaction time output, showing that overall, the 11 year old participants' reaction time performance was slower than the 14 year olds for the intermediate and complex clock faces. It should be noted, however, that no interaction between the Group and Complexity factors was found, and so it is true for all participants.

3.6.3.5 Correctness

Correctness refers to the matched and mismatched times presented to the participant. Matched times are those where the analogue and digital comparison are the same, whereas the mismatched times are those where the analogue time differs from the digital time. It would appear that for Correctness, irrespective of 'matched' and 'mismatched' levels, the control participants were quicker in their reaction time than the dyslexic participants.

The results continue to display the same trend in relation to the matched and mismatched clock faces that showed significant differences in accuracy. The dyslexic participants are consistently slower, lagging by $\approx$ 2 seconds. Interestingly though, the reaction time for the matched clock faces is slower than the mismatched clock faces by 0.02 seconds across both groups, but this is non-significant.

Further, when analysing the mismatched clock faces across the complexity range, the results continue to indicate similar trends. The reaction time differences increased as questions became more complex and the reaction time “pause” increased for the dyslexic cohort when compared with their control counterparts.

It is evident from the results that the dyslexic participants in this study underperformed in this reaction time experiment. When compared with their control counterparts, the dyslexic performance appears to be delayed against that of the control performance into their middle teens, though there is improvement with maturity.

3.7 Overall Summary for Section 1

It was hypothesised that dyslexia can affect time telling skills. Indeed, this hypothesis has been found to be correct, as shown through the Time Comparison Task findings presented in Section 1.

Chapter 4 Link Chapter

4.1 Introduction

This chapter aims to provide a link between the child centred Time Comparison Task (TCT) and adult time management. Cross-sectionally, skill performance was measured between the children taking part in three age groups. The transition to the adult investigation was achieved through questioning adults about their childhood experiences with mathematics and time telling, and developing the theme into time management skills and practices. Further, investigations aspired to probe understanding of timetables, organisational skills, coping strategies and career development.

The TCT in Section 1 sought to determine differences in accomplishment between dyslexic and non-dyslexic children. The accuracy and reaction time performances of the three age groups showed differing results. The dyslexic children were consistently slower and less accurate when responding to the test stimuli. It was, however, discovered that by early teens the dyslexic cohort was becoming more accurate. Their accuracy performance was only marginally weaker than their non-dyslexic counterparts. Reaction time too, improved though only marginally for controls when compared with the non-dyslexic group and consistently lagged behind across the two older age groups.

Given that the dyslexic performance is weaker in the TCT, the result supports the findings of other researchers who have examined dyslexic type weaknesses in other areas of mathematics cognition (Miles et al., 2001; Turner Ellis, 2002). Moreover, dyslexia research in vocabulary understanding and articulation (Hitch & McAuley, 1991), rapid naming (Wolf et al., 2002), automatisation (Nicolson & Fawcett, 1990), memory (Geary, 1993; Geary et al., 2000), and visual perceptual understanding (Helland & Asbjønsen, 2003), have provided evidence of the difficulties experienced by individuals. Further, research in time telling (Burny et al., 2011; Friedman & Laycock, 1989) has provided evidence of weaker developmental skills. Kirby et al. (2008) refer to continuing issues in adulthood with reading and spelling and attribute the difficulties to weaker word recognition, comprehension and memory.

These vulnerabilities cause delay in learning which results in the necessity to revisit information to achieve understanding and to progress learning forward. It is this revisiting which in a practical sense may contribute to under or overestimating temporally the length of time a task might take. As a child, these weaknesses, though noticeable, are supported with the help of parents and teachers so that issues of time and skill development are managed “externally” to the child. In adulthood where independence is encouraged, these challenges become more profound and are exemplified. To maintain a position at work, to monitor progress and the passage of time, therefore, requires additional resources from elsewhere. Consequently, the dyslexic may need to develop coping strategies to accommodate for the additional demands on resources to time manage.

The implication of the problems experienced by dyslexic adults may be summarised in the following example of a practical nature. Imagine projecting forward in time when the dyslexic child is now an adult possibly displaying similar difficulty in a commonplace scenario. They are standing on the platform of Waterloo Station considering which train to catch. They are shown a plethora of information displayed on a vast information board, which shows times of numerous trains to different destinations in the twenty-four hour digital time. Often these times are constantly changing. The board too, changes, by scrolling in new information to update movements on the ground. Elsewhere on the platform there are analogue clocks showing the current time. Given that the dyslexic might need to choose a train about to leave the station, there is likely to be a significant level of pressure to make a quick and accurate decision and dash. In addition, this may be compounded by the general melee of people running around the station, adding to a stressful situation. The dyslexic who has difficulties processing the time, pairing and sequencing the events of the train’s arrival or departure with the time on the board, understanding platforms, finding the platform and getting on the train in sufficient time, may well find the experience quite daunting. Further, if the dyslexic finds reading timetables a challenge, then under stressful circumstances as described, they may well become confused and so are likely to seek help.

4.2 Time Management

With difficulties in working memory, automaticity, phonological deficiencies and slow processing, how might this affect dyslexic adults’ time management skills of organisation, planning and goal setting? Further, how might deficiencies in these areas affect dyslexics in other ways? In order to gain a broader insight into the experiences of time management that dyslexics have, questions were devised to determine the processes of time management to investigate the potential associated emotional effects, including coping strategies.

Efficiency and productivity are the overall goals of good time management (TM). TM contributes towards reducing stress (Hawkins & Klas, 1997) and helps provide a control structure such as organisation, output and focus. Without TM higher stress levels emerge, weaker performance in the task ensues and ultimately unprofessional behaviour potentially emerges (DiGiacomo & Adamson, 2001).

Proficient TM skills are good predictors of Grade Point Average (GPA) (Britton & Tesser, 1991) – the statistical measure of children's and adults' educational development in the US – and time management practices are important for academic success. Further, the only skill ranked above time management for GPA is goal setting as a predictor of success (George, Dixon, Stansal, Gelb, & Pheri, 2008).

Much of the research to date on time management has been anecdotal, and the aim of the questionnaire devised for this research was to extend our knowledge of the subject. To attain success, having a clear goal in mind is important together with careful planning (Covey, 1989). Additionally, TM offers greater efficiency with available time, which leads the individual to become better organised, feel a greater sense of well-being and subsequent happiness. Part of the present research was, therefore, aimed at determining if dyslexic adults used these skills to help organise their time effectively.

A developmental connection between childhood time telling and adult time telling is presented next in Metamemory.

4.3 Metamemory

Metamemory is the awareness an individual has about their own memory capacity and the strategies they may use to help make it more effective when learning. Within the child and student domain, study skill strategies such as SQ3R – Survey, Question, 3R (Read, Write and Review) are taught. This strategy promotes recall and learning, thereby making management of academic work more efficient time wise. Study skills rely too, on judgement of success whether it be through exams or in remembering material learned, so that allocation of and modification of memory skills are implemented.

It is not known whether adults have a precise appreciation of the mechanisms involved with memory for time or the development of their ability (Friedman, 2007). Moreover, there is little knowledge of children's development in this area or whether it differs from adults. Friedman (2004) though, observed ten main properties relating to human memory associated with time. Some aspects such as being able to remember when events occurred were found to be more vivid if there was an important event which coincidentally happened. Otherwise, the memory for the time of an event is usually approximate and decays over a period. Equally, the order that related incidences occur, in particular the contiguity of the event, is remembered more accurately than those which are unrelated. Remembering an event such as one's own birthday is generally retrieved directly.

Though adults are often assumed to have a sound understanding of time and to be able to organise their time effectively throughout their day, anecdotal evidence suggests that some time-oriented exercises such as time planning, punctuality, timetabling and use of timetables prove to be difficult areas for dyslexic adults to master (Miles et al., 2001). Likewise, going back in time to the childhood of a dyslexic, similar issues such as forgetting the time of an appointment or lesson, knowing what lesson is coming next, recalling their timetable and forward planning have been reported.

One theme of this thesis in *dyslexia and time* is to explore if difficulties experienced by dyslexic adults in time management could be linked to difficulties in understanding time in childhood. From the child-centred results in Section 1 it is evident that the dyslexic participants improve in accuracy of time telling with age, though their response times lag behind those of their non-dyslexic counterparts. Beyond the age of 14, however, little is known about further development in time telling and any associated connection with other external temporal processes such as timetables.

According to the GCSE and A-level syllabus, and indeed the International Baccalaureate (IB) programme, emphasis switches from direct time telling to the study of elapsed time and problem solving involving calendars and other time related activities such as historical times. At A-level and within the IB diploma programme, more advanced time related concepts are taught with respect to distance-time, velocity-time and displacement-time graphs and problem solving using the 24 hour clock and time zones. In part, this prepares the student for independent travel as an adult.

One area which is of importance for dyslexic students, especially beyond the age of 14, is that of managing time for examinations. Equally, responsibilities beyond this age for children change with an expectation of their being more independent in homework, for example. Parents and teachers place less emphasis on time telling and more on time management at this point, whereby they encourage the use of homework diaries which are independently and often solely administered. The aim is to instil guidance for successful course and homework management.

In the case of dyslexic students, their homework demands are likely to be much more challenging as often it will take them longer to cover the work required of them. Deadlines for activities and final year projects all place demands on time management skills which, if poorly organised or managed, may prove a challenge. One observation made of students which extends into adult behaviour in task completion has been perceived by the author; if tasks require longer than anticipated to progress, then dyslexics seek to use their private time more as a buffer toward task completion, often leading to inordinate lengths of time being spent to achieve conclusion. This is most evident in school when teachers suggest that students only take an hour to do their homework based on the teacher’s assessment of the task. Often parents of dyslexic youngsters have stated that their child might take many times the recommended length and in some cases have simply resigned to submitting incomplete work. In some circumstances, this type of expectation leads young people to become overwhelmed with the demands placed on them. This characteristic becomes endemic of the educational establishment in the mind of an individual, potentially causing self-esteem issues to arise. When the same individual manages to qualify for Further Education and sees this as a “new start”, perhaps with intent to manage their time better, they find the same problem emerging. Further Education or indeed the workplace feels less inviting, particularly as young adults “are on their own” often without the support of their primary ally, their parents.

In more recent years, Further Education establishments have become much more dyslexia friendly, to enable students to be able to benefit from support, but this is not always the case when individuals move into the workplace. If the dyslexic does not receive formal training in time management approaches or has a lack of self-taught coping strategies, then in the workplace there is potential for some of the issues of poor time management to become evident. The use of modern technologies at home or at work, such as e-mail for report writing, seen as being beneficial for job completion, can become a burden to dyslexic individuals if these are the only available approaches to carry out their work. Touch typing, writing and spelling in this medium is likely to be a challenge and the portability of the technology to home will inevitably result in work extending into home life as a means of coping. Further, as time is often constrained, requiring tasks to be completed in time scales organised by others, dyslexics are sometimes at a disadvantage as they require more time than most. In dyslexia friendly schools extra time is often specified for school projects or exams, which is not likely to be the case in the workplace.

In these circumstances, therefore, a dyslexic perceives that their difficulties with writing, typing, processing or time taken are affecting their job performance. Often, they compare themselves with others, as they would have done as children. Given that they are able to cope elsewhere in their role, self-esteem becomes affected when their TM and writing skills are observably weak. The employer worries that the individual is unable to manage, and the employee, in order to cope, will often devote more personal time just to keep ahead of the demands of the task. In time demanding tasks, where an employer is unfamiliar with dyslexia, observations of this nature might have an adverse effect on relationships and thoughts of career advancement.

In these situations, therefore, it is essential that the strengths and weaknesses of individuals are understood and that in the case of dyslexic adults, their time management is monitored to establish understanding. Chapter 5 presents the adult questionnaire in detail along with findings. It is designed to find out more about time management approaches and principles that dyslexic people report as being weak.

Chapter 5 Section 2 Adult Questionnaire

5.1 Introduction

An adult questionnaire was devised to gain a fuller understanding of how dyslexia affected adults in their day-to-day life. A number of primary areas were explored from childhood into adulthood including experiences of mathematics understanding, learning time, time management and organisational skills, career choice and lifestyle choices. Further, a number of questions were postulated which are presented in the next section.

5.2 Aims of this Chapter

This chapter is designed to address the hypothesis that dyslexic adults describe finding personal time management more difficult than non-dyslexics.

To investigate this hypothesis in such a broad topic area, answers to the following questions were sought. These questions provided the foundation structure of the questionnaire.

Question 1: *Will the dyslexic participants refer to greater difficulty with mathematics than the non-dyslexic participants?* (The range of questions on mathematics skill preceded questions relating to time telling). The answers given might help determine if there was a correlation between mathematics skills and time telling, and may complement the findings of the time recognition task presented earlier in this thesis.
Question 2: *Will dyslexics show greater concern for time and aspects of time?*
Question 3: *Will dyslexics find personal time management difficult, compared with non-dyslexics?*
Question 4: *Will dyslexics embrace technology as a means of coping with their time management skills?*
Question 5: *Do dyslexic participants report finding overestimating and underestimating time a challenge when compared with the non-dyslexic group?*
Question 6: *Will reading timetables by the dyslexic group prove more difficult for them than the non-dyslexic group?*
Question 7: *Will dyslexia influence career choice and lifestyle changes?*

5.3 The Questionnaire Methodology

The questionnaire was designed to be thorough in its investigation of participants' experiences with time and time management. The early part of the questionnaire considered responses to questions aimed at participants' school experience and in particular their ability with mathematics. The later questions provided a forum to discuss time and time management, the role of technology, career choice and general time observations. A general time observation question at the end gave the participants an opportunity to reveal any additional information they felt relevant.

A series of open ended and closed questions were presented in each of ten parts of the questionnaire. Each part developed the theme of time management through encouraging individuals to convey their experiences. The assortment of questioning techniques used such as open, closed, leading, multiple and ranking questions (Oppenheim, 1992) sought to extract as much information from participants as possible. Some questions were designed with an appropriate Likert Scale to measure skill development.

The questionnaire (see Appendix A.8) was uploaded to the internet for completion by those happy to use this form of technology. Hard copies of questionnaires were also provided to participants preferring this medium, or the researcher on request would visit the participant to help complete the questionnaire in a more congenial atmosphere.

Outlined next are the ten primary themes of the questionnaire.

1. General Background Questions and Demographics

Consisting of three questions, this part entitled "General Background Questions" was designed to ascertain participant understanding of dyslexia, how dyslexia affected them emotionally and practically, and if they had been formally assessed for dyslexia. Those who had been formally diagnosed would be able to convey from their perspective the true meaning of their difficulties. This could lead to an "*actual*" versus "*theoretical*" insight of dyslexia, providing actual experiences of their difficulty. In contrast, comparing their views with non-dyslexics may reveal a different understanding of dyslexia, whereby, the non-dyslexic by nature is likely to present a more theoretical view rather than a personal experience.

In addition, it was anticipated that there would be an age effect in their knowledge of dyslexia as a term that has received more media coverage recently. It is possible that the term dyslexia has been heard more by the younger than the older participants. It should be noted, however, that some aspects of the questionnaire are retrospective in nature as the questions rely on participants' memories of their schooling and their perception of their difficulties at that time. If though, as is the case with the researcher, some memories of difficulties are still vivid, then the questions asked will enable participants to convey their experiences.

Two further general background questions were asked with regard to attention deficit disorder (ADD) and attention deficit hyperactivity disorder (ADHD). Participants were asked if they knew of the condition and if they believed they had ADD or ADHD. If they thought they had the disorder then they were excluded from taking part in the research. This syndrome can be present with dyslexia, but is more likely to have a greater impact on poor reading and spelling because of interference affecting normal learning processes.

The term control in this part of the thesis is used interchangeably with the term non-dyslexic. It should be noted this is representative of those participants who regarded themselves as non-dyslexic in accordance with the 'General Background Questions'.

In summary, these questions were asked to gain an understanding of the actual and theoretical concepts of dyslexia and to filter for additional syndromes that could affect learning, such as co-occurring ADD and ADHD. As with the children's experiment it was felt that ADD and ADHD might influence the outcome of responses.

2. As a Pupil at School 7 - 16 years

Comprising seven questions, this part was designed to determine the nature of difficulties, if any, these adults had with mathematics as children. The broad spread of some questions targeted primary mathematics skills in early childhood, which involved the foundation blocks of mathematics. Some questions were made open-ended to enable participants to elaborate on their experiences; others were simple "yes/no" questions or rating type questions presented in a tabulated format. The desire was to engage the participants in such a way that they would offer insight into their mathematics learning. Questions about multiplication facts, time and some spatial skill acquisition were asked as these are areas of mathematics known to be challenging for dyslexics (Burny et al., 2011; Turner Ellis, 2002). In addition, questions designed to determine emotional experiences at this age were asked. It has been found that emotional experiences can affect the performance of individuals. Further, a question was asked to discover who had the greatest influence on the participant as a child. This was to ascertain if there was a leaning toward peer group pressure when tackling the subject of mathematics, and indeed if support was given in mastering mathematical skills.

In summary, the questions in this part were chosen to explore support mechanisms for participants and general understanding of mathematics topics taught in school at this age.

3. Learning Time – As a Pupil at School 7 - 16 years

From the broader perspective of the previous questions, this part, which comprised eight questions, was designed to discover participants' knowledge of time with an emphasis on understanding whilst still at school. Time vocabulary was examined and individual experiences of the topic explored. Questions ranged from a detailed rating scale to open-ended and closed questions.

In summary: This section was aimed at investigating time and the ability of participants to tell time at a young age.

4. Time as an Adult 17+ years

This set of five questions explored participants' time experiences as adults, and guided participants to answer questions about timetables. A mix of open-ended and closed questions was chosen to enable free rein of thought. Emphasis was placed on determining if time telling was difficult and if travel timetables devised to help the public to plan their travel arrangements were understood. With the advent of the internet, some timetables for flying and booking tickets have evolved from the list type timetables of the past. It was felt important to examine this area in more detail, to gain an appreciation of participants' experiences.

In summary, as adults, understanding everyday time related operations such as timetables might be a challenge for some dyslexics. This section of questioning examined participants' experiences.

5. Day-to-Day Time Management

The 15 questions in this part were devised to examine the participants' day-to-day time management skills. Beginning with an open-ended question, participants were asked about their understanding of the term *time management*. The following questions explored their use of a diary both at work and at home and if they operated the diary independently or with support. Did participants cope by using special strategies to help plan their day? The use of closed questions about diary usage and open questions about organising time, both at work and at home, helped to provide a rich forum for them to elaborate on their experiences.

In summary, effective time management is a skill which can be difficult for some people to master. The questions in this part were aimed at investigating this aspect.

6. Technology and Time Management

Technology is now widely obtainable to help manage time and there are number of portable electronic devices available. The purpose of questions on this theme was to determine usage of technology by dyslexic and non-dyslexic adults. If dyslexic participants do not like using paper diaries, because it requires writing in appointments, what do they use instead? Perhaps technology is easier and a more convenient tool. A series of eight questions was devised to examine the use of electronic devices for personal time management. In addition, what type of device and how they were used was of interest, to gain an understanding of their assistance with day-to-day planning. Further, the last question which is both a “yes/no” response, and an accompanying open-ended question, asked if technology helps the participant feel more in control.

In summary, has technology come to the aid of participants to help with their day-to-day time management?

7. Career Choice

Career choice for adults can sometimes be difficult but, for a dyslexic adult, career choice might be affected additionally by their literacy skills. This series of six questions endeavours to examine a participant’s career choice and influences on it. Two questions were devised to ascertain if there was a trend which distinguished the dyslexic group from the non-dyslexic group through their career choice. Two primary career choices were anticipated to emerge, namely academic and practical.

In summary, the questions asked in this part were chosen to determine if there was a different pattern of career choice which might emerge between the non-dyslexic and dyslexic groups.

8. Lifestyle

These five open-ended questions considered lifestyle and any lifestyle changes dyslexic adults may have made to accommodate for any of their difficulties. It would be interesting to discover a common theme emerging with the dyslexic participants who might feel that their condition did indeed affect their lifestyle.

In summary, questions in this section were asked to explore the possibility that dyslexia may have an effect on the choice of lifestyle made by the dyslexic group. The aim here was to determine if this was the case.

9. Time Observations

This cluster of questions was devised to gain a clear understanding of personal time observations and emotions relating to people's experiences. It is anticipated that the dyslexic participants would show a more fastidious approach to their own time management method, and might display feelings toward other perceived non-dyslexic approaches to similar situations.

Time moves on relentlessly and the management of it is essential for the smooth planning of ever-increasing demands placed upon it. This series of 12 questions studied the parameters of time that are controllable through forward planning. Questioning guided the participant to consider topics such as punctuality, both their own and others', which is an important issue for some, with the need to be over-punctual being a possible characteristic of their dyslexia. It was of interest to find out if participants regarded lateness as being rude.

Idiosyncratic behaviour was also studied in this section together with the participants' capacity to overestimate / underestimate time in performing tasks.

It is predicted that routine is an important factor for dyslexic people. Examining the need for routines, which enable the smooth running of the day, were explored to determine differences between the dyslexic and non-dyslexic groups.

Dyslexic people can sometimes find it difficult organising their own time, so a question was devised to determine if they were responsible for organising other people's time, and if so how.

In summary, the questions asked in this part were designed to determine if observations of other people and time related activities were different between the dyslexic and non-dyslexic groups.

10. Open Observation and Reflection

For completeness, it was decided to invite the participants to offer any further comment or thoughts on the questionnaire. This gave the individuals an opportunity to elaborate on their experiences of time issues if they wished.

The questionnaire was thorough in measuring appropriate responses to the questions devised by the researcher and it was designed to be completed in a 30-40 minute timeframe.

5.4 Pilot Study

Five participants not included in the final research were engaged to pilot the questions, to determine question ambiguity, clarity of understanding and repeatability of intent. The participants were asked to advise on the appropriateness of the questions from both an ethical and an analytical perspective and if the questions were readable for the target dyslexic audience. The participants were asked if they perceived the intended thread the researcher had wished to convey in the design. In addition, advice was sought from statisticians in the Psychology Department of the University of Chester, to ascertain the achievability of the desired final analysis. Further advice was sought from the Learning Information Services (LIS) at the University to have the questionnaire made available on the internet. From this pilot study the questionnaire was modified and the uploaded version was trialled for ease of access and ease of retrieval of data from the on-line storage database. Some technical issues did emerge at this stage but were successfully rectified. The piloting participants found no difficulty accessing the questionnaire on-line and indeed preferred the experience. The researcher too, found transmitting the questionnaire over this medium much more convenient. There was also the option for participants to receive a hard copy of the questionnaire in the post. Further, it was decided that if participants requested the researcher to visit them and act as a scribe, then this would be provided.

At this phase, consideration was made of the nature of the data selection and analysis. Some of the qualitative data were analysed using Template Analysis. Text data was organised into themes drawn from the answers to the questions. The data were initially converted to mind-map presentation for across group and age comparison - phrases, words and comments were collected together under specific headings in this format to make subsequent theme codes.

The resulting quantitative data were analysed using SPSS where appropriate.

5.5 Participant Choice

The dyslexic participant volunteers for this research were largely known to the researcher through his role as a special needs tutor teaching dyslexic children, and were parents of known dyslexic children. In some cases, these adults had been formally diagnosed with dyslexia or were believed to be dyslexic through their own self-assessment. Other dyslexic participants volunteered as a result of a mail shot from Professor T.R. Miles (OBE) at Bangor University and through Professor T.J. Wheeler at the University of Chester. The researcher found other participants interested in taking part through “word of mouth”.

The participants were self-selecting and taken from an open sample of candidates. All candidates volunteered and there was a 100% uptake of all that took part. There was no specific selection of participants through their cognitive ability, their spelling profile or their intelligence quotient, though preliminary screening for attention deficit disorder (ADD and AD(H)D) was conducted resulting in two respondents being excluded. This exclusion for a known co-occurring factor fits the criterion adopted for the Time Comparison Task to establish that the condition would not affect the results. The participants are not recorded in Table 5.

The adult participants comprised 46 males and 38 females, aged between 18 and 64 years, in order to encompass a broad spectrum of adult life. Table 5 summarises the proportion of dyslexic and non-dyslexic participants. Though the sample size is non-specific and open to any number of participants, it was thought to be a reasonable population for the purpose of this part of the thesis.

Table 5 summarises the dyslexic and non-dyslexic groups by age and gender who took part in the questionnaire.

Table 5: Participant Numbers for Group Separated by Age

	Age	
	18 – 44 years	45 – 64 years
Dyslexic Female	8	7
Control Female	13	10
Dyslexic Male	16	12
Control Male	8	10

5.6 Adult Questionnaire Results and Analysis

The analysis of questions is based on the relevance to the experiment, and in particular, to the hypothesis outlined at the beginning of this chapter. There is a range of both quantitative and qualitative analysis, to gain a distinct understanding of the data.

Each question that yielded findings of interest is presented in turn under its primary theme. The question number is given a “Q” prefix to represent “question” followed by the question number used in the questionnaire e.g. Q1.1.

5.6.1 General Background

All participants contributed fully to the questions. It was observed that the female participants were more forthcoming about their experiences compared with their male counterparts. In addition, the dyslexic participants both from the male and female groups responded more fully to the questions compared with the non-dyslexic participants, possibly because they were most relevant to their experience.

Q1.1 "What do you understand by the term dyslexia? Please state:"

The results showed that 88% of the participants responded to this question. Both the dyslexic and non-dyslexic groups shared similar views of their understanding of the dyslexic syndrome. Both groups referred to reading, spelling and writing difficulties in near equal proportions. However, for mathematics the dyslexics reported characteristic difficulties stemming from the condition compared to the non-dyslexic participants. There was no statistical difference using χ^2. Therefore, overall, in their basic understanding of the characteristics of dyslexia there was no difference between the two groups.

Q1.2 "If you consider yourself to be dyslexic; in what ways emotionally and practically does it affect you?"

The overall sample size was 84 participants, in the proportion of 46 males to 38 females. There were six male and eight female participants who had been formally identified dyslexic (16.6%) of the participant population. There were 20 male and seven female participants who regarded themselves as being dyslexic, (32% of the participant population) but had never been formally tested. Many of the dyslexic participants were known by the researcher, as their dyslexic children were taught by him. Further, many of the young dyslexic participants had also been taught by the researcher when they were at school. The rest of the participants did not regard themselves as dyslexic.

Q1.3 "Have you had any detailed assessment carried out by a Psychologist for dyslexia?"

Of those who were formally diagnosed, nine came from the 18-44 age group (21%) of the dyslexic participant population) and five came from the 45+ age group (11%). In addition, there were 15 from the 18-44 age group (35%) who considered that they were dyslexic and 14 from the 45+ age group (33%).

Q1.4 "Do you believe that you have Attention Deficit Disorder (ADD)/ Attention Deficit Hyperactivity Disorder (AD(H)D)?"

There were two candidates, one male the other female who regarded themselves as showing an AD(H)D profile and so they were excluded from the research and were not used in any of the analysis.

5.6.2 As a Pupil at School 7-16 years

Q2.3 "Listed below are topic areas in mathematics. Please indicate on the rating scale how hard these topics were for you:"

This question was presented as a rating scale of the primary topics in mathematics at age seven to 16. The primary topics were numbers, shapes, trigonometry, statistics, graphs and algebra. Participants graded their ability in each of these topic areas from very easy (1) to very hard (7).

An independent samples *t*-test was performed and participants in the non-dyslexic group recalled finding the primary mathematical topics easier (mean = 3.36; SD = 1.61) than the dyslexic group (mean = 4.20; SD = 1.55) with an effect size (d= 0.036), $t(81) = 2.47$, p =.008 (1 tail). It is therefore concluded that dyslexic participants in this sample found the primary topics of mathematics more difficult than the non-dyslexic group (see Appendix D.1).

Examination of the individual topic types revealed that dyslexics found topics involving visual-spatial processing more difficult than non-dyslexics with results as follows: graphs $t(79) = 2.95$, p=.002 (1 tail); trigonometry $t(81) = 2.46$, p =.008; algebra $t(80) = 2.1$, p =.02; shapes $t(80) = 1.75$, p =.042. Numbers and statistics, while more difficult for dyslexics, did not achieve significance (p= .085) (see Appendix D.2).

Q2.4 "What were your experiences? <u>Please comment</u> on the following: (Memory for Maths, Multiplication Facts, Telling Time, Elapsed Time, Celebrations)"

This question is relating to memory of mathematics, specifically targeting memory for multiplication number facts when at school. A rating scale from very easy (1) to very hard (5) was chosen to determine the participant mastery of multiplication number facts, to ascertain any noticeable difference between the two condition groups.

An independent *t*-test was performed for the reported level of difficulty across a range of multiplication number facts. The dependent measure was a mean of the rating scale indicating the level of difficulty collapsed across the 12 multiplication tables. Participants in the non-dyslexic group recalled multiplication facts more easily (mean = 1.69; SD = 0.79) than the dyslexic group condition (mean = 2.3; SD = 0.85) (see Appendix D.3). An independent *t*-test supported the experimental question $t(79) = 3.25$, $p = .002$ (2 tail) effect size ($d = 0.076$) (see Appendix D.4). It is, therefore, concluded that dyslexic participants found multiplication number facts more difficult than the non-dyslexic participants. This is supported by independent research in dyslexia and mathematics (Turner Ellis, 2002).

5.6.3 Learning Time - As a Pupil at School 7-16 years

Q3.8 "Different aspects are listed below. Please indicate on the rating scale how hard these areas of time were for you:"

This comprised a table of 17 sub-questions that were initially collapsed together for the main analysis as they all relate to aspects of time. An independent t-test was performed on the mean response (difficulty) to these questions, on a scale of 1 (very easy) to 7 (very hard) that included aspects of everyday time related topics. There was a significant difference between the non-dyslexic group (mean = 4.93, SD = 1.93) and the dyslexic group (mean = 6.75, SD = 2.79), $t(80) = 3.40$, $p = .001$ (2 tail) effect size ($d = 0.37$) (see Appendix D.5 and D.6). It is therefore, concluded that dyslexic participants, found general aspects of time more difficult than the non-dyslexic group (see Table 5.1).

Table 5.1: Statistical Summary of Collapsed Aspects of Time Between Group

	Dyslexic versus Control Group
A - Telling Time	$p < 0.05$
B - Timetables	$p < 0.05$
C - Birthdays	$p < 0.05$
D - Peers	ns
E - Time Phases	$p < 0.001$

Further evaluation of the specific topic groups revealed that there are some significant differences between the dyslexic and non-dyslexic groups with "Telling Time", "Timetables", "Birthdays" and "Time Phases", together with signs of differences between age groups with "Timetables", "Birthdays" and "Time Phases" (seasons, years, weeks, months, and days of the month).

An investigation of the difference between the dyslexic (mean = 3.47; SD = 1.4) and control (mean = 2.22; SD = 1.05) participants for "Time Phases" showed significance (see Appendix D.7). An independent *t*-test revealed support for the experimental question t (df=80) = 4.54, p=.001 effect size (d=0.29) (see Appendix D.8). It is therefore concluded that the dyslexic participants found everyday time telling more difficult than the control group.

5.6.4 Time as an Adult 17+ Years

Q4.1 "As an adult did you or do you have difficulties with time? Please comment:"

A cross tabulation and 2x2 χ^2 was carried out to discover whether there was any association between the group and time. The analysis was based on the two categories of response, "no" which meant no difficulties, compared to "yes" which included difficulties with "time management", "dates and dates elapsed" and "24 hour clock". The χ^2 value of 3.22 had an associated probability value of p=.036, df =1 (1 tail). This showed that there was an association between the group and time management, which suggests that dyslexic participants do experience greater difficulty with everyday time management, dates, days, and elapsed time. The following table represents their responses (see Table 5.2 and Appendix D.9, D.10 and D.11).

Table 5.2: Three Main Areas of Difficulty with Time

		Group		Total
		Control	**Dyslexic**	
As an adult did you or do you have difficulties with time? Comments	No	**33**	**27**	60
	Yes – time management	6	12	18
	Yes – dates, days, elapsed time	0	2	2
	Yes – 24 hour time	2	2	4
	Yes - Total	**8**	**16**	24
	Total	41	43	84

Note: numbers in bold used in reported Chi-square analysis

Q4.4 "If a timetable is difficult to understand do you ask for help? Please comment:"

This question was asked to determine if dyslexic participants had a greater difficulty understanding timetables than the non-dyslexic participants. A simple "yes" / "no" response was encouraged followed by the chance to make any additional comments. The comments of individuals were categorised into areas of specific themes.

Of those who took part, 45 participants contributed a "yes" or "no" comment, whereas 39 left this question blank. There were 40 "yes" and 5 "no" responses. The cross-tabulation table below illustrates the distribution of comments for the dyslexic versus non-dyslexic groups. The comments have been combined into four themes (see Table 5.3 and also Appendix D.12).

Table 5.3: Four Primary Responses to Timetables

		Group		Total
		Control	**Dyslexic**	
If a timetable is difficult to understand, do you ask for help? Comments	No	**2**	**3**	5
	Yes – I ask directly for help without referring to a timetable	2	9	11
	Yes – lack of confidence	11	9	20
	Yes – if complicated	6	1	7
	Never ask – look stupid	0	2	2
	Yes - Total	**19**	**21**	40
	Total	21	24	45

Note: numbers in bold used in reported Chi-square analysis

It can be observed overall that the dyslexic participants prefer to seek the help of others when confronted with a difficult timetable rather than solve it for themselves. The non-dyslexics appear to prefer to solve the timetable and then ask if it proves too difficult. The dyslexic then lacks the confidence to ask, if the task is too complicated. Some dyslexics decide not to ask in case they 'look stupid'.

A χ^2 evaluation was carried out to determine whether there was a significant association between the responses of the group and help seeking behaviour. The χ^2 result of 0.1 had an associated probability value of p=.75, df = 1. It can therefore be concluded that there is no significant association between the responses of the dyslexic and non-dyslexic groups.

5.6.5 Day-to-Day Time Management

Q5.2 "Do you have difficulties with organising your time? Please comment:"

In order to gain an understanding of time management, this question was asked to determine if dyslexic participants had difficulty organising time in comparison to the non-dyslexic participants. This open-ended question gave the participants the opportunity to make comments. These comments were categorised into themes based on those responses.

Of those who took part, 81 responded "yes" or "no", while three made no response. Forty participants contributed a "no" response, whereas 41 made a "yes" comment which was categorised into six main themes.

Table 5.4 illustrates the responses to Q5.2 and refers to the six main themes to emerge linked with difficulties organising time.

Table 5.4: Six Main Themes Linked with Difficulties Organising Time

		Group		Total
		Control	Dyslexic	
Do you have difficulties with organising your time? Comments	No	**24**	**16**	40
	Yes	2	7	9
	Yes – by prioritising	2	2	4
	Yes – tend to waste time	5	2	7
	Yes – poor organisation, planning, get distracted	2	7	9
	Yes – need routine	0	3	3
	Yes – try to do too much, overwhelmed	4	5	9
	Yes - Total	**15**	**26**	41
	Total	39	42	81

Note: numbers in bold used in reported Chi-square analysis

The dyslexic participants, in general, appear to show greater difficulty with organising their time, with respondents reporting becoming more distracted, and having a feeling of being poorly organised with their time management.

A χ^2 evaluation was carried out comparing all “yes” versus “no” responses for the Group. The χ^2 result of 4.45 had an associated probability value of p =.035, df = 1, (2 tail). This result suggests that there is a significant association between group and difficulty organising time.

Q5.3 “At work do you have a diary?”
and *Q5.8 “Who runs your diary?”*

Further investigation of these two questions was warranted as it was felt that the use of a diary might differ between the dyslexic and non-dyslexic groups. Moreover, given that diary usage requires some organisational skill, if the dyslexic found this difficult, were they inclined to seek help from others with diary management. Of the 84 participants, 78 responded with a “yes” or “no” response. Twenty seven dyslexic participants said they used “a diary at work” compared with 25 non-dyslexic participants. Thirteen people in both groups said they “did not have a diary”. Ten dyslexic participants went on to state that they relied on third party help including spouses and secretaries to run their diaries compared with seven non-dyslexic participants (see Appendix D.13).

Q5.9 “Do you rely heavily on this help? Why and how? Please comment:”

When participants were asked if they relied heavily on technology for help, 35 responded, of which 12 said “no”, 23 said “yes” stating reasons as illustrated below. Forty-nine made “no comment”. On closer examination of the 23 “yes” respondents, both dyslexic and non-dyslexic groups presented similar reasons for their use of diaries and reliance on technological help.

Below are a number of quoted responses from the male and female dyslexic and non-dyslexic participants. The participants have been given a unique code as follows: Participant DM45-1 refers to Group-Gender-Age-Participant Number e.g., (Dyslexic- male- 45 (45 to 64 years old)-participant 1).

Dyslexic Males

- *“I rely on the reminder. My main job function spans weeks so I need the reminder to stop the main job function to attend associated meetings (project meetings).” (Participant DM45-1)*
- *“My wife always remembers the key social dates/occasions. My mind delas (sic) with the business and work agendas.” (Participant DM45-4)*
- *“Yes - without it my day would be totally chaotic!!” (Participant DM45-19)*
- *“Yes because i (sic) would not like to be hald (sic) responable (sic) for booking in jobs for the whole company as my time management is not soo (sic) great.” (Participant DM18-7)*

Non-dyslexic Males

- *"I didn't realize how heavily I relied on my PA until I changed jobs and didn't have one." (Participant CM18-13)*
- *"Yes, need to make sure I have enough time allocated for the preparation of each lesson." (Participant CM18-5)*
- *"No as I don't always remember to enter appointments etc." (Participant CM45-12)*

Dyslexic Females

- *"It helps me organise things running throw (sic) my head. And so I don't panic about forgetting so much." (Participant DF18-4)*
- *"Keep me organized and directed." (Participant DF45-2)*
- *"Days seem to run away with me, I forget lots of meetings and when I should be teaching, if not reminded." (Participant DF45-4)*
- *"Yes. Need to keep checking." (Participant DF45-8)*

The "no" respondents who were dyslexic made comments leaning toward relying on others to help them to keep organised:

- *"I rely heavily on people around me reminding me of meetings etc." (Participant DF45-5)*

Non-dyslexic Females

- *"No. I rely on having it there, but generally I took the time to write it into the calendar I remember it vai (sic) the fact that I wrote it and/or the fact that I glace (sic) at it a couple times a day in my time planning." (Participant CM45-8)*
- *"Yes because it would be impossible for me to remember everything in my mind. How - I wriie (sic) down meetings/events as I am told and at the start of the year it helps me to plan more efficiently." (Participant CF45-4)*
- *"Yes. I rely heavily on my paper diary. Without it I wouldn't be able to remember my appointments." (Participant CM45-9)*

Q 5.10 "Do <u>you</u> adopt special strategies for yourself in organising your time? Please comment:"

This was an open–ended question asked to determine if any special strategies were adopted between the groups. It was hoped to gain insight into the practices of individuals dealing with organising their time.

Of the questionnaire sample, 57 (67.9%) participants answered the question and 27 (32.1%) left the comments section blank. Of the 57, 24 (42%) answered "no" to the question compared with 33 (58%) who answered "yes", with additional comments supporting their approach in organising their time. Those who answered "yes", adopted strategies that were categorised into one of eight subcategories. Table 5.5 illustrates the collation. Appendix D.14 presents the frequency analysis.

Table 5.5: Question 5.10 - Eight Themes Linked with Special Strategies

		Group		Total
		Control	Dyslexic	
Adopted strategies	No	**14**	**10**	24
	Yes – target, Prioritize	3	5	8
	Yes – notes, to do lists, post-it notes	4	6	10
	Yes – colour codes, Mind maps	1	1	2
	Yes – 3rd party help	0	1	1
	Yes – careful planning	2	6	8
	Yes – rewards for achievements	1	0	1
	Yes – spread appointments	1	1	2
	Yes – use technology for storage	1	0	1
	Yes - Total	**13**	**20**	33
	Total	27	30	57

Note: numbers in bold used in reported Chi-square analysis

It can clearly be seen that “careful planning” ahead was an important strategy for the dyslexic participants where six participants (30%) found that this worked for them. Six (30%) of dyslexic participants adopted reminders in the form of “post-it” notes and “to do lists” to help in organising their time management. In contrast, two (15%) of the non-dyslexic participants indicated that “careful planning” ahead was an important strategy for them, compared with four (30%) who preferred to use reminders in the same way as the dyslexic cohort.

Setting a target to achieve goals seemed important for both groups with dyslexic participants preferring this method (25%) compared to the non-dyslexic group (23%). This result suggests that both groups share similar ideas.

5.6.6 Technology and Time Management

Q6.1 “Do you have any particular problems remembering dates/times of events and attending them? Please comment:”

Of the 84 participants, seven (17%) in the non-dyslexic group said they did have problems remembering dates and times, compared with 22 (51%) of the dyslexic group. In contrast, 33 (80%) of the non-dyslexic participants said that they “did not”, compared with 20 (47%) dyslexic participants. Two participants made no response.

A cross tabulation and 2x2 χ^2 was carried out to discover whether there was any association between group and dates/times. The χ^2 value of 10.906 had an associated probability value of p=.004, df=1(2 tail), showing that there is a significant association between group and dates/times of events. This supports the theory that dyslexic participants report greater difficulty remembering dates and times of events. Table 5.6 illustrates the group response to Q6.1. Appendix D.15 presents the chi-square results.

Table 5.6: Group Response to Question 6.1

		Group		Total
		Control	Dyslexic	
Do you have any problems remembering dates?	**Yes**	**7**	**22**	29
	No	33	20	53
	No – response	1	1	2
	No - Total	**34**	**21**	
	Total	41	43	84

Note: numbers in bold used in reported Chi-square analysis

Q6.2 "Does this cause you to become anxious, stressed or feel poorly organised in the day? Please comment:"

This was an open-ended question that was asked to determine if any feelings of anxiety were experienced and what those were, if the groups were similar, and if this was related to age and group. It was hoped to gain insight into the practices of individuals dealing with organising their time and overcoming their anxiety or stress.

A frequency tally of the response to this question was carried out. Of the 84 participants, 53 participants made comments about their experiences. Twenty-two (26%) said "no" to becoming anxious, stressed or to feeling poorly organised. Thirty-one (37%) gave a "yes" response, citing five primary feelings in support of their answer. Thirty-one (37%) participants did not respond. Table 5.7 illustrates the group response to Q6.2.

Of the 31 "yes" responses recorded, eight (26%) were made by the non-dyslexic group, compared with 23 (74%) by the dyslexic group. Looking at the 32 dyslexic participants only, seven (22%) of the dyslexic group stated that they became upset with themselves compared with only one (3%) of the non-dyslexic group.

A cross tabulation and 2x2 χ^2 was carried out to discover whether there was any association between the group in response to this question. The χ^2 value of 5.96 had an associated probability value of p=0.015, df=1 (2 tail).
It can therefore be concluded that there is a significant association between group and stress. This supports the notion that dyslexic participants feel more anxious. Appendix D.16 presents the chi-square results.

Table 5.7: Group Response to Question 6.2

		Group		Total
		Control	Dyslexic	
Do you become anxious? Comments	No	**13**	**9**	22
	Yes	5	9	14
	Yes – supposed to be somewhere	0	2	2
	Yes – upset with myself	1	7	8
	Yes – feeling of command	1	1	2
	Yes – hate to be late	1	4	5
	Yes - Total	**8**	**23**	31
	Total	21	32	53

Note: numbers in bold used in reported Chi-square analysis

Presented below are some of the varied comments made by a number of the participants who answered this question. It helps illustrate the experiences that the dyslexic participants have in connection with their time management and how the feeling of anxiety affects them. These are direct quotes taken from the questionnaire relating to the answering of this question only.

Dyslexic Males

- *"Sometimes I feel really cross with myself for forgetting because I have let a person down in something i (sic) was supost (sic) to do. and something i (sic) find it hard to understand why i (sic) can't remember these things." (Participant DM18-7)*
- *"I do not like to be late and find it slightly disrespectful if kept waiting more than 20 minutes after the agreed time." (Participant DM18-15)*
- *"Yeah especialy (sic) when I realise that im (sic) supposed to be some ware (sic) and im (sic) rushing and worring (sic) before i (sic) get there because im (sic) not prepeared (sic)." (Participant DM18-1)*
- *"I organise myself the night before, but so worry about getting somewhere on time." (Participant DM18-2)*
- *"If I forgot my diary I would (sic) anxious." (Participant DM45-11)*

Non-dyslexic Males

- *"Not really because i (sic) rember (sic) on the day what i (sic) need to do and the rest of the year is in my phone calendar." (Participant CM18-2)*
- *"No - diary is reliable." (Participant CM45-8)*

Dyslexic Females

- *"If I have to rush because I've stuffed up the alarm clock I feel unprepared for the day." (Participant DF18-6)*
- *"Ye(sic) sometimes a (sic) I fing (sic) thongs (sic) start to get on top of me and I get stressed." (Participant DM45-3)*
- *"I don't like letting people down but I no longer stress about it." (Participant DM45-5)*
- *"I feel anxious quiet (sic) often if I used time badly and not fitted in things I want to do." (Participant DM45-8)*

Non-dyslexic Females

- *"I do not like feeling disorganized!" (Participant CF18-8)*
- *"If I'm late I 'm a bit annoyed with myself." (Participant CF45-4)*

Q 6.3 "Does being organised to remember dates/times of events help you to feel better? e.g. happier, etc. Please comment:"

This was a "yes" / "no" response and open-ended question, which was asked to gain an understanding of any emotional feelings emerging from the perception of being better organised. It explored whether individuals feel less stress as a result.

A frequency tally of the response to this question was carried out. Of the 84 participants, 79 (94%) said "yes" to feeling better when being organised. Three participants (3.6%) gave a "no" response and two (2.4%) participants gave no response.

There were fewer open-ended written responses than the "yes/no" section. 51 candidates wrote in varying detail, which resulted in two primary themes emerging – "relaxed and confident" and "control". Of the 51 written responses recorded; 10 (20%) were made by the non-dyslexic group, compared with 29 (57%) by the dyslexic group. Thirty-one per cent of the dyslexic responders stated that they felt more in command compared with 24% of the non-dyslexic responders. In addition, 25% of the dyslexic group stated that they were more relaxed and confident, compared with 20% of the non-dyslexic group.

The "yes" responses were collapsed and analysed for significance across the groups. The χ^2 value of 0.002 had an associated probability value of p=.964, df=1. It can therefore be concluded that there is no significant association between group and the feeling of organisation (see Appendix D.17, D.18 and D.19).

Despite the lack of observable differences revealed by the chi-square results, presented below are some of the varied comments made by a number of the dyslexic participants who answered this question. It appears that anecdotally, the dyslexic participants do feel more relaxed, in "control", and less stressed when they perceive that they are better organised. These are direct quotes taken from the questionnaire relating to the answering of this question only.

Dyslexic Males

- *"I can relax, knowing how long i (sic) have till that date, and how much time i (sic) have to prepper (sic)." (Participant DM18-1)*
- *"It gives me a feeling that i (sic) have things under control." (Participant DM18-5)*
- *"Beecause (sic) you know what you are doing and it means you should be in a rush and get into a mess." (Participant DM18-6)*
- *"Far less stressful, particulary (sic) when home and work times do not compete or clash." (Participant DM45-6)*
- *"I feel that I am managing my time and the jobs that I have to do." (Participant DM18-15)*

Non-dyslexic Males

- *"Feel more relaxed when i (sic) am more organised." (Participant CM18-5)*
- *"Yes I suppose it does. gives (sic) you a sense of inner confidence." (Participant CM45-14)*

Dyslexic Females

- *"I feel more adept - on target." (Participant DF18-9)*
- *"I love the sence (sic) of achevment (sic) when I have everything tidy + myself organised. It makes me feel really good + controlled." (Participant DF18-4)*
- *"I like to be orgainised (sic) then i (sic) am calmer." (Participant DF45-3)*
- *"Like a security blanket. I used to make huge efforts and buy all sorts of aids – Do (sic) you remember the filofax? Left mine on a train. I'm rather surprised and pleased with myself when i (sic) do remember things but I don't beat myself anymore when I forget." (Participant DF45-4)*
- *"Avoids stress." (Participant DF45-6)*

Non-dyslexic Females

- *"It gives me a feeling of control over the frenzied pace of life." (Participant CF18-4)*
- *"I feel "in control" and this allays anxiety." (Participant CF45-4)*

Q6.4 "Do you use technology to help organise time?"

This question was asked to determine if there was a trend toward greater use of technology to help with organising time. Many new electronic devices are available to help people with their day–to–day lives. This simple "yes" or "no" question would help in discovering a trend, if one existed, between the groups.

A frequency tally of the response to this question was carried out. Of the 84 participants, 29 (34.5%) said "yes" to using technology to help their organisation, 53 participants (63.1%) gave a "no" response, and two (2.4%) participants gave no response.

Of the 29 "yes" responses recorded, 15 (52%) were made by the non-dyslexic group, compared with 14 (48%) by the dyslexic group. Of the 53 who said no, 47% came from the non-dyslexic group compared with 53% from the dyslexic group (see Appendix D.20).

A cross tabulation and 2x2 χ^2 was carried out to discover whether there was any association between the groups in response to this question. The χ^2 value of 0.156 had an associated probability value of p=.693, df=1 (Appendix D.21). It can therefore be concluded that there is no significant association between group and technology.

Q6.5 "What do you use? Please indicate: computer, PDA, message recorder, electronic diary, other"

Individuals checked a tick box to indicate the type of technology used. The choices given were modern technologies, which were available at the time of the research and were at an affordable price.

Of the 84 participants, only 23 (27%) contributed to this question with the remainder 61 (72.6%) choosing not to respond.

Of the 23 responses which were recorded, seven (30%) were made by the non-dyslexic group, compared with 16 (70%) by the dyslexic group. Of the non-dyslexic group, equal numbers preferred the computer, and electronic diary. For the dyslexic group, the majority (57%) showed preference for an electronic diary compared with 18% for the computer. The dyslexic participants appear to prefer the technology that is more mobile. This might suggest the immediacy of the technology is most important to them (see Appendix D.22).

Q6.6 "How does the technology help you to organise your time?"

This was an open-ended question designed to give participants the opportunity to elaborate on how the technology helps them to organise their time. There were 44 responses to this question with a further 40 who neglected to provide a reply. Twenty-five dyslexic participants responded to the question compared with 19 non-dyslexic participants. The responses were either "no" or "yes", with the "yes" responses being themed into one of five categories. Of the groups, (44%) preferred to use mobile telephones or PDA with alarms, citing that it helped them by prompting appointments. Computers and the benefits of their organisational strengths ranked second (32%). Participants liked the "fixed" nature of having a central location to which to refer. Of the two groups, the non-dyslexics (53%) preferred the computer compared with the dyslexic group (16%), while the dyslexics preferred the mobile telephone and PDA (47%) compared with the non-dyslexic group (40%). There were 23% who said they did "not use technology to help them" while 18% preferred paper diaries, and all of those were from the dyslexic cohort.

Table 5.8: Illustrates the group response to Q6.6.

Table 5.8: Group Response to Question 6.6.

		Group		Total
		Control	**Dyslexic**	
How does the technology help you to organise your time? Comments	No	**4**	**6**	10
	Yes – phone, PDA alarms, reminder, prompt	6	9	15
	Yes – paper diary	0	6	6
	Yes – computer availability and up-to-date	2	0	2
	Yes – computer organised, central place	6	3	9
	Yes– saves time	1	1	2
	Yes - Total	**15**	**19**	34
	Total	19	25	44

Note: numbers in bold used in reported Chi-square analysis

The "yes" responses within the five primary responses were collapsed for the technology used, and analysed for significance across the group. A cross tabulation and 2x2 χ^2 was carried and there was no association between group and how technology helps.

Q6.7 "Does this technology make you feel more in control? Please comment further:"

This question comprises a "yes" or "no" response and an open-ended comment response. It was intended to assess and compare the usage of technology by the group and if it assisted in organisational skills and helped improve time management control.

A frequency count was carried out on both the “yes” and “no” responses and the open-ended responses were scrutinised for themes. Of the 84 participants, 51 responded with a “yes” or “no” answer and 33 did not respond at all to the question. Of the total respondents, 28 (55%) answered “yes”. This compared with 23 (45%) responding “no”. The open-ended part to this question was answered by 24 participants with 60 participants missing the question. Five themes which emerged were isolated from the “yes” responses and of those, the non-dyslexic participants gave eight (33%) responses compared with 16 (67%) by the dyslexic participants. From Table 5.9 it can be seen that 38% of the dyslexic participants reported feeling more in command with the help of technology compared with the non-dyslexics (25%).

Table 5.9: Group Response to Question 6.7.

		Group		Total
		Control	**Dyslexic**	
Does this technology make you feel more in control? Please comment further:	No	**3**	**4**	7
	Yes – independence	0	3	3
	Yes – command	2	6	8
	Yes – backup	1	1	2
	Yes – flexibility of use	1	2	3
	Yes – planning ahead	1	0	1
	Yes - Total	**5**	**12**	17
	Total	8	16	24

Note: numbers in bold used in reported Chi-square analysis

A cross tabulation and 2x2 χ^2 found no significant association between group and use of technology.

Despite the lack of observable differences revealed by the chi-square analysis; presented below are some of the varied comments made by a number of the dyslexic participants in response to this question. This helps to illustrate the experiences that the group has in connection with their use of technology and how it helps control their time management. These are direct quotes taken from the questionnaire.

Dyslexic Males

- *"I would say it make (sic) me feel in control if i (sic) have to rely on a moble (sic) phone to run my life. i (sic) would feel happyer (sic) if i (sic) could remember everything." (Participant DM18-7)*
- *"I miss less things. I get more done. Others can help me plan (as my diary is shared). I like the fact that I can move things and the diary will always look tidy! The ability to make meetings and things electronically means that I can involve others in helping me manage my diary in practice to some extent. PLUS - I often forget to follow up time critical things and the electronic approach means that when I do remember to do something, I can go and check it afterwards etc." (Participant DM18-11)*
- *"It helps me to keep in control of what I'm doing and to inform the people I have to communicate with." (Participant DM18-15)*
- *"It gives me the power to be independent and remember things." (Participant DM18-5)*

Non-dyslexic Males

- *"When I remember to use it." (Participant CM18-13)*

Dyslexic Females

- *"If I hear the reminder I am okay, I know I will get to a meeting on time, but I worry that if I lose my smartphone (sic) then chaos will prevail." (Participant DF45-4)*
- *"Not in contol (sic) - but some belief that arrangements/appointments will happen on time." (Participant DF45-7)*
- *"Otherwise wouldn't get around to dealing with issues or contacting friends." (Participant DF45-8)*

Non-dyslexic Females

- *"Technology allows me to accomplish more, communicate better, and organize my life more efficiently." (Participant CF18-4)*
- *"As long as it is stored safely that is fine." (Participant CF45-2)*

5.6.7 Career Choice

Q7.1 "What job title do you have?" **and**

Q7.2 "Briefly, please outline your career path to date:"

These two questions were devised to ascertain if there was a trend that distinguished the dyslexic group from the non-dyslexic group through their career choice. Two primary career choices emerged, namely, academic and practical. A frequency analysis was performed on the data together with a cross tabulation for the group.

Of the 84 participants, 78 contributed to this open-ended question. Six participants made no response.

Related careers were identified which fell under the two themes, where 28 were academic and 50 were practical. Of the academic career path, 15 were chosen by the non-dyslexic participants compared with 13 dyslexic participants. In contrast, the practical career choice was made by 20 non-dyslexic group participants compared with 30 dyslexic participants.

Figure 5 illustrates that the dyslexic participants tended to move more to a practical career path than an academic one (see Appendix D.23).

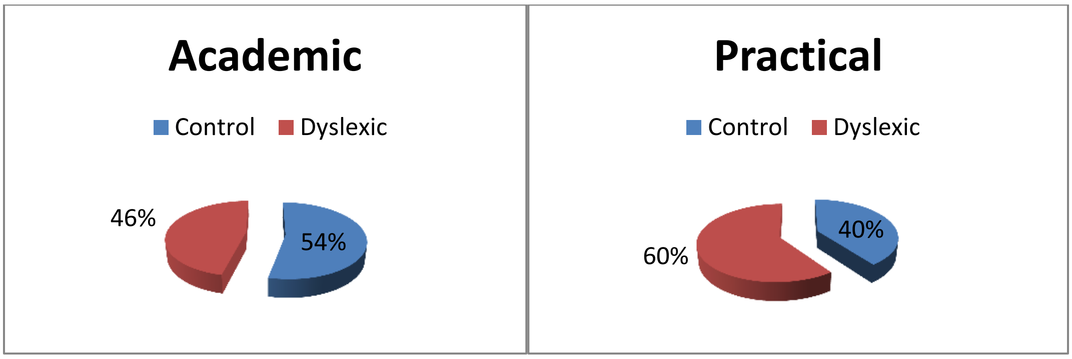

Figure 5: Percentage Distribution of Practical versus Academic Career Choice made by Group

Q7.3 "Why did you take your career path? Please rank from 1 (most important) - 8 (least important) the following influences:"

This was a two part question giving the participant the opportunity of ranking possible influences on their career choice. The following list of influences was presented as: "Free choice", "Interest", "Encouragement", "Parental", "Teacher", "Skill", "Forced Choice", and "Peers". The second part of the question was an open-ended response for candidates to expound on their career choice.

The order defined by the two groups governing their career choice was: 1) Interest, 2) Free Choice, 3) Skill, 4) Encouragement, 5) Parental, 6) Teacher for the non-dyslexic group, 6) Peers for the dyslexic group, 7) Peers for the non-dyslexic group, 7) Teacher for the dyslexic group, 8) Forced Choice (see Appendix D.24).

Q7.5 "Do you feel that your career has been affected by dyslexia? How? Please comment:"

This question comprises a "yes" or "no" response and an open-ended comment response. It was intended to examine if dyslexic participants felt that their career had been influenced more through their difficulties than their non-dyslexic counterparts. The open-ended part of this question enabled both groups to elaborate on their experiences.

A frequency count was carried out on both the “yes” / “no” responses and the open-ended responses. Of the 84 participants, 76 responded with a “yes” or “no” answer and eight missed answering the question. Of the total who responded, 30 (39.5%) answered “yes”. This compared with 46 (60.5%) who responded “no” to the question. Of the 30 “yes” responses recorded, 25 (83%) were made by the dyslexic group and of the 46 who said “no”, 39% came from the dyslexic group (see Appendix D.25).

Outlined below, are some of the responses given by the dyslexic and non-dyslexic cohort to this open-ended question.

Dyslexic Males

- *“I feel trapped by the systems (sic) way of paperwork being the most important thing, not being able to project my strong points. making (sic) me work twice as hard on simple things such as producing an assignment which describes what i (sic) really want it to say as most of the time the words on the page don’t reflect what is in my head.” (Participant DM18-4)*
- *“Academic qualifications more difficult to obtain - impacted career options. Time issues impacted performance and work/life balance.” (Participant DM18-10)*
- *“Led me to work for myself.” (Participant DM18-12)*
- *“I have to work harder at certain things such as letter writing etc.” (Participant DM18-13)*
- *“I still ask how to spell (sic) I have to double check my calculations (sic) I will not take fipchart (sic) notes in a meeting.” (Participant DM18-14)*
- *“I have learnt to play to its strengths and adapt the way I work to compensate for its failings. Oh, and thank goodness for the spellchecker! I do find that Excel sheets can cause my eyes to go funny and I will have to use a digit or highlight a row in order to read the information correctly. Sycometric (sic) tests have also caused a certain amount of angst, but the more I've done the less tha (sic) worry. I now enjoy the challenge.” (Participant DM18-4)*
- *“Don't like doing reports, (sic) have to do in own time as I take a long time.” (Participant DM45-2)*
- *“Did not get the qualifications to be a surveyor.” (Participant DM45-3)*

Non-dyslexic Males

- *“Sensory over load frustration, relating to the way other people think can be very difficult.” (Participant CM18-1)*

Dyslexic Females

- *“I didn't do A levels, I did a GNVQ, therefor (sic) I didn't get into a very good course at university. This has had an effect on my career as I can't get onto graduate schemes.” (Participant DF18-3)*
- *“When I was at College (sic) I wanted to work with young children. But didn't have the grades + wuld (sic) have to re-sit the exams.” (Participant DF18-4)*

- *"Having difficulty expressing myself on paper and retaining knoweledge (sic) has prevented me reaching my full potential." (Participant DF18-6)*
- *I need all my letters etc. to be checked, staff know I forgot (sic) things and are forgiving." (Participant DF45-4)*
- *"I left school because I felt I would perform poorly in exams. I went to secretarial college because a "careers" teacher literally sent me there and I didn't think I had an option." (Participant DF45-5)*

Non-dyslexic Females

- *"Seeing and working with so many children with dyslexia has taught me many new ways of teaching those with and those without. It has forced me to look at the way children learn and that has helped many children." (Participant CF45-5)*

These responses do appear to suggest that participants' career choice has been affected by their dyslexia to varying degrees. References are made to writing difficulties and having difficulty gaining qualifications, which appears to have had a noticeable impact. Slow reading or poor reading skills, lack of motivation, low self-esteem in adult life (Riddick et al., 1999), low productivity and lack of enjoyment for academic development, have influenced the preferred practical career choice of dyslexics.

5.6.8 Lifestyle

Questions 8.1, 8.2 and 8.3 were combined in the analysis to help establish a theme.

Q8.1 "Has your lifestyle been affected by dyslexia?"

This question was asked as a preamble to the following questions in this part. It is anticipated that dyslexic people have developed coping strategies to help themselves with their dyslexia, through adopting changes in their lifestyle.

A frequency count was carried out of this open-ended question on the basis of participants making a "yes" and "no" response. Of the 84 participants, 72 responded and 12 missed answering the question. Of the total who responded, 19 (26.4%) answered "yes". This compared with 53 (73.6%) who responded "no". Of the 19 "yes" responses recorded, 16 (84%) were made by the dyslexic group and of the 53 who said "no", 49% came from the dyslexic group (see Appendix D.26). Three non-dyslexic participants responded to this question as their partners were affected by dyslexia and so they recorded that they made lifestyle adjustments to accommodate their partners.

Q8.2 "Have you made lifestyle changes because of your dyslexia?"

This question comprises a "yes" / "no" response and an open ended comment response. It was intended to examine if dyslexic participants felt that they had made lifestyle changes as a result of their dyslexia.

A frequency count was carried out on the "yes" / "no" responses and the open-ended responses. Of the 84 participants, 63 responded with a "yes" or "no" answer and 21 missed answering the question. Of the total who responded, 11 (17.5%) answered "yes". This compared with 52 (82.5%) who responded "no" to the question, and of the 11 "yes" responses recorded, nine (82%) were made by the dyslexic group. Of the 52 who said no, 55% came from the dyslexic group (see Appendix D.27). Further, two non-dyslexic participants stated that they adapted their lifestyle to suit their dyslexic partners.

Q8.3 "What lifestyle changes have you made and why?"

This question was open-ended to enable the dyslexic group to elaborate on their experiences. This was a difficult question to answer for many of the participants, as lifestyle changes are broad in nature. It appears that a number of participants have made the decision to become self-employed and that technology to help these people is emerging. It appears that under the notion of lifestyle changes, some participants have adopted avoidance strategies for writing, in favour of technology.

Q8.4 "What advice would you have for other dyslexics?"

Specifically aimed at the dyslexic participants, this question gives the respondent the opportunity to elaborate on any advice they may have to fellow dyslexics, based on their experiences. The object of this follow-on question was to see if there were any common threads running through their advice.

This question provoked a good response from participants. Clearly, the participants felt empowered to make a contribution. Though aimed at the dyslexic participants, the non-dyslexic participants also made some positive statements to this question. The open-ended part to this question was answered by 44 participants with 40 participants missing the question. "Seeking help and support" was one of six categories which were isolated from the participants' responses. Thirty five per cent of the dyslexic group responded to this category, presumably because they appreciate the obvious benefits of receiving help. A large proportion of this group (32%) also suggested that fellow dyslexics should take control, to gain confidence and never give up (see Appendix D.28). Anecdotally, there appears to be a high level of determination amongst the group. Some of the positive comments made by the dyslexic group are presented in Appendix D.42.

5.6.9 Time Observations - On Your Own and Other People's Behaviour

This cluster of questions was devised to gain a clearer understanding of the dyslexic group's personal time management and if they observed the time management of others. It was anticipated that the dyslexic participants would show a more fastidious approach to their own time management in a variety of ways, such as arriving for a meeting well in advance to make sure they were there, or to become anxious when planning a flight. If they are conscious of their own time difficulties, do they compensate for it, and are they sympathetic in their observations of other people and their time management?

The following five questions were combined (9.1, 9.2, 9.3 9.5, 9.7) for analysis in order to extract a general theme from the dyslexic responses. All of these questions, except question 9.7, comprised of a "yes" or "no" response together with an accompanying open-ended written response opportunity. Where there were open-ended questions, specific topical themes were created which were common to the replies given by participants.

Q9.1 "Do you have any observations of other people and time? If yes, what do you notice?"

This question was asked in order to determine any personal observations that dyslexic participants might have toward other individuals and their time management. Of the 84 participants, 77 answered with a "yes/no" response to the first part of the question. Seven participants left this part unanswered. Of the 77, the "yes" responses attracted 26 (34%) from the non-dyslexic cohort, compared with 35 (45%) from the dyslexic cohort. In contrast, the "no" response was far less for both cohorts at 10 (13%) for the non-dyslexic group and 6 (8%) for the dyslexic group (see Appendix D.29 and D.30).

Of the 58 participants who gave a response to the open-ended part of this question, the majority were made by the dyslexic group (57%). The primary themes which emerged were those of poor time management by dyslexics, and observations of others whereby, "they seemed to make time management look easy". Indeed, some commented that people were "too relaxed" about time management. Of the non-dyslexic group more referred to rushing to achieve their goals. Interestingly, both groups appeared to prioritise arriving early for an appointment.

Q9.2 "Are you a person who is a stickler for punctuality? Why?"

This question was asked as an extension to the Q9.1 with a greater emphasis on an individual's personal idiosyncrasies, if any exist, which relate to their own punctuality. The aim was to discover if there was a measurable difference between the dyslexic and non-dyslexic groups. The "yes" or "no" response section captured 81 participants responses. Similar numbers of responses were made by both groups, with only a small number (three) more from the dyslexic group. Of the 55 "yes" answers, 30 (55%) were made by the dyslexic group compared with 25 (45%) from the non-dyslexic group. In contrast, the "no" responses attracted 26 participants, with the non-dyslexic group showing a marginally larger number 14 (54%) compared with 12 (46%) dyslexic group responses (see Appendix D.31).

From the comments made, both groups considered punctuality to be important, with the dyslexic group attributing greater importance to the politeness and courteousness of their actions.

The non-dyslexic group cited reliability as an important factor raised by this question and the dyslexic group stated more than the non-dyslexic group that being punctual helped alleviate the stress they experienced when attending appointments.

Q9.3 "Expectation - if you are punctual, do you expect others to be also? Why?"

This question was asked to establish if, by being self-motivated enough to be punctual, the dyslexic participants expect others to act in the same way. Both parts to this question stimulated a large response with 79 answering "yes" or "no", with five abstentions and 71 making relevant comments to the open-ended section of the question. Analysis of the qualitative data from the open-ended part to this question, consolidated responses to eight main themes. These themes were: "not punctual", "arrived too early", "hate lateness", "rude", "politeness", "reciprocal effect", "don't like wasting time", and "other". These themes were kept broad in order to capture enough detail and gain a clearer understanding of participants' thinking (see Appendix D.32).

Of the overall sum of responses, 55% came from the dyslexic group and 45% from the non-dyslexic group. Further analysis revealed that of the two groups, the dyslexic participants regarded poor punctuality to be "rude" (59%), and that for "politeness" to be on time was essential (58%). The same group disliked "lateness" (58%). Other emotions which emerged were frustration, anger, and stress (see

Appendix D.33). Outlined below are some of the comments made by the dyslexic and non-dyslexic participants to this question.

Dyslexic Males

- *"Like my father was, i (sic) hate when people are late, i(sic) feel like im (sic) waiting around for them, its rude." (Participant DM18-1)*
- *"If a time is set you should be there to start at that time, so arrive 5 minuets (sic) early. Its (sic) good manners and means that the event can start and finish on time." (Participant DM18-2)*
- *"Its (sic) the polite way to be and it's also unfair on others who are waiting for you if your (sic) late becuase (sic) if i(sic) have maid (sic) the effort to get somewheree (sic) others should do the same just out of respect." (Participant DM18-10)*
- *"I feel that it (sic) a sign of respect." (Participant DM18-14)*
- *"Time is presus (sic) and I don't like wasting it." (Participant DM45-2)*

Non-dyslexic Males

- *"I don't know why I do, I almost get frustrated if people are late for a meeting or an arrangment (sic). I think it's because I have taken some of my personal time to do something with/or for someone else and if they don't care as such then why should I give up my time." (Participant CM18-2)*
- *"Depends on situation: with friends, I don't necessarily expect them to be on time, especially the ones I know are regularly late. For more formal events I would expect people to be on time." (Participant CM18-3)*
- *"I feel it is good manners." (Participant CM18-4)*
- *"Time is precious - particularly at work." (Participant CM18-13)*
- *"Respect." (Participant CM45-13)*

Dyslexic Females

- *"Loyalty, if not always totally rational." (Participant DF18-9)*
- *"I think its (sic) really rude if someone is late. Once in a while doesnt (sic) bother me but when someon (sic) is constantly late and its going to directly affect me than that really bothers me." (Participant DF18-1)*
- *"I think that if I can be punctual others can also be." (Participant DF18-3)*
- *"Because it would be rude if they didn't make the effort." (Participant DF18-4)*
- *"I think it can be a sign of either laziness in others or sometimes lack of organization by others." (Participant DF18-9)*
- *"Manners and respect." (Participant DF45-2)*
- *"I try to be punctual for others because its (sic) courteous to be so. I don't think it is acceptable to deliberately waste others' time." (Participant DF18-5)*

Non-dyslexic Females

- *"I want others to respect my time as much as I try to respect theirs." (Participant CF18-3)*
- *"I expect others to (sic) punctual in the workplace most of the time. Outside of the workplace I don't expect anyone to be punctual - unless of course it is an emergency situation." (Participant CF18-4)*
- *"Yes, when time matters. For example, meetings at work concern the personal time of a large group of people, and therefore should start on time. If I'm at the meeting at 9, I expect it to start. In casual manners, i.e. meeting up with friends, getting ready to go out, I think the area is a little more gray (sic). If I'm ready for dinner at 7, but my friend needs 5 more minutes to finish doing her hair, that's fine by me." (Participant CF18-2)*

- *"Common courtesy." (Participant CF18-7)*
- *"I am punctual when its (sic) vital and I suppose that I presume that others see things in the same way! I don't like people leaving late for my meetings - it feels like they are not taking it seriously." (Participant CF45-4)*

Q9.4 "How does it affect you? Please comment:"

This question follows on from the previous questions and was devised to provoke further intuitive reaction from participants to the leading questions in this part. The aim was to determine any meaningful qualitative data that summarised the observational behaviour.

As an open-ended question, it gave free rein for expressions of any feelings toward punctuality of others. Analysis of quantitative data was consolidated into seven main themes. These themes were: "doesn't", "moaned at", "annoying", "frustrating and stress", "try to be early", "affected my time and planning" and "don't like being kept waiting". Generally, the responses given by the participants across the groups mirrored one another. Both groups cited annoyance, frustration and stress as being their primary emotions. The dyslexic participants also indicated a marginally higher degree of anxiety and stress (see Appendix D.34).

Q9.5 "Do you have any particular behaviour with time issues, e.g. over-concern for punctuality, anxiety when time moves on? Please describe this behaviour:"

This question was formulated to explore further any particular behaviour with regard to time that the dyslexic and non-dyslexic groups may have. This was an open-ended question that guided the participants to consider their emotional experiences with regard to time issues. Of the 84 participants, 41 made comments on this question. Analysis of quantitative data was consolidated into nine main themes. These themes were: "no", "yes – always in a hurry / hate to be late", "yes", "cross and angry", "anxious and stressed", "running out of time", "frustrated", "embarrassed", and "reduced performance". Sixty-four per cent of the dyslexic participants claimed that they were always in a hurry and hated to be late, compared with 36% of their non-dyslexic counterparts. The dyslexic participants (73%) cited the feeling of being cross and angry compared with the non-dyslexic group. The dyslexic participants also indicated a marginally higher degree of anxiety and stress and were the only group to indicate frustration as an emotion (see Appendix D.35).

Q9.6 "Do you underestimate / overestimate the time to do tasks? Please comment:"

Underestimating and overestimating the time taken to perform any task can be a challenge. This question was conceived to determine if the estimation was more demanding for the dyslexic participants compared with the non-dyslexic group. The "yes" or "no" answers revealed that of the 84 participants, 75 gave a response and nine participants missed responding. There were a greater number of answers given by the dyslexic participants (56%) compared with the non-dyslexic group (44%). Of the 48 "yes" answers, 28 (58%) were made by the dyslexic group compared with 20 (42%) from the non-dyslexic group. In contrast, the "no" responses attracted 27 participants, with the non-dyslexic group showing a marginally smaller number; 13 (48%) compared with 14 (52%) for the dyslexic group. Analysis of the quantitative data from this open-ended question was consolidated into five main themes. These were: "no", "overestimate", "no problem estimating", "underestimate", and "both". These themes were kept broad in order to capture enough detail and gain a clear understanding of participants' thinking.

Of the 84 participants, 60 answered the question with a written elaboration of their experiences and 24 chose to leave this blank. Of the 60 responses, 31 (52%) were made by the dyslexic participants compared with 29 (48%) for the non-dyslexic group. Overestimating, was cited as the primary difficulty, and followed closely by underestimating. The dyslexic participants outnumbered the non-dyslexics in both traits. Fifteen (58%) dyslexics compared with 11 (42%) non-dyslexics cited overestimating a problem and 12 (57%) dyslexics and 9 (43%) non-dyslexics cited underestimating as a trait (see Appendix D.36 and D.37).

Q9.7 "Do you prefer set routines?"

This question was asked in order to determine if there was a difference between groups concerning a desire for routine. Dyslexic participants might like the comfort and support of routines to help them feel more command. This was a "yes" and "no" type question and a frequency count carried out, established that between the two groups, 81 participants chose to answer, with 51 saying "yes" compared with 30 who said "no". Comparing the groups in both answers, the dyslexics show a higher number of responses than the non-dyslexic group. It does appear that in both groups, these participants preferred to have some level of routine to maintain their time management (see Appendix D.38).

Q9.8 ***"At work, what kind of routines relating to time do you like? Please comment:"*** **and**

Q9.9 ***"At home, what kind of routines relating to time do you like? Please comment:"***

Questions 9.8 and 9.9 were combined to establish if routines were important for the two cohorts and both questions were open-ended to enable participants to impart their experiences. The aim was to examine any differences that might emerge from their responses.

The importance of whatever routine is established is usually personal to an individual. Routine, however small, can help with the comfortable running of an individual's day, taken from personal experience. There are some occasions, however, where individuals may need to combine or adapt their routines to fit in with the needs of others, such as a work team for instance, where there is a need for flexibility. Home routine and work routine were presented as two questions for consideration, to distinguish any subtle differences between the two environments. Of the 84 participants, 71 made comments to this question compared with 13 who neglected to respond. There were a greater number of answers given by the dyslexic participants (58%) compared with the non-dyslexic group (42%). Analysis of quantitative data from this open-ended question was consolidated into six main themes. These themes were: "no routine", "no not keen", "yes", "yes like it", "yes - reluctantly" and "no interventions". These themes were kept broad in order to capture enough detail and gain a clear understanding of participants' thinking.

Of the 84 participants in the group, 71 (84.5%) answered the question with a written explanation of their experiences, and 13 (15.5%) chose to leave this blank. Of the 71 responses, 41 (58%) were made by the dyslexic participants compared with 30 (42%) for the non-dyslexic group. Equal numbers of participants from both groups found that they liked routines at work, though a larger number of dyslexic participants (73%) had no routine or were not keen on routine than the non-dyslexic participants (27%).

A cross tabulation and 2x2 χ^2 was carried out to discover whether there was any association between the group and routine at work (Question 9.8). The χ^2 value of 1.17 had an associated probability value of $p = 0.2793$, df = 1. It can therefore be concluded that there is no significant association between the group and work routine.

A cross tabulation and 2x2 χ^2 was carried out to discover whether there is any association between group and routine at home (Question 9.9). The χ^2 value of 1.20

had an associated probability value of $p= 0.2726$, df = 1. It can therefore be concluded that there is no significant association between group and home routine (see Appendix D.39, D.40 and D.41).

Q10 "Any other comments you may have regarding time, or additional thoughts and feelings."

This final question gave participants the opportunity to add any further information to enrich their questionnaire responses. There was a wide variety of thought conveyed with the dyslexic group highlighting a strategy in coping with work demands, that of bringing it home. Additionally, observations made by both groups included the importance of using time efficiently as it is a precious commodity and thoughts that time management is difficult to accomplish.

These are direct quotes taken from the questionnaire in response to this question:

Dyslexic Males

- *"If done in a relaxed manner I find that my chaotic mind can form logical steps in time management but life is not always relaxed so I try and find easier routes to follow this relaxed path. I will always get there in the end." (Participant DM18-5)*
- *"I found it a lot easier when in a set routine and would normally get a lot more work done if on a set routine." (Participant DM18-6)*
- *"Just realised that I have long had no concept of age/growing older. Time is clear when planning the future, confusing when present and once passed just 'disappears'." (Participant DM18-11)*
- *"Nature of my work means I have many jobs to do and not enough time. Often bring work home." (Participant DM45-2)*
- *"I'm amaized (sic) at how many people in TV have Dyslexia: Jack Dee – Comedian, Thingy Blackstock - Writer/ Comedian, Charlie Boorman – Actor, Susan Hampshire – Actress, Kenny Logan - Sportsman/ Come Dancing. If they have reading issues, how do they learn their lines?" (Participant DM18-15)*
- *"I waste more time than make use of time but it is just the way I am." (Participant DM45-3)*
- *"Society today is demanding more and more from the time of the day and we must all move forward in unison to maintain a satisfactory balance. I'm looking forward to retirement when my time becomes more of my own." (Participant DM45-11)*
- *"You should be aware that time is slipping by and you should try to cram a lot into it as you possibly can. At 20 yrs (sic) age you feel you have all the time in the world." (Participant DM45-15)*

Non-dyslexic Males

- *"Time is a man-made thing in creating time we are able to organise are (sic) time if you like. If there wasn't time things would be a lot different." (Participant CM18-2)*
- *"Telling the time is an academic venture and as such easy. Keeping track of time is all together another matter." (Participant CM18-1)*
- *"I think most people when young have difficulty in understanding time and its passing and how this affects others but change as they accept responsibilities." (Participant CM45-3)*

- *"Time is precious." (Participant CM45-8)*

Dyslexic Females

- *"I find that I am hard on people who are slower than me." (Participant DF18-5)*
- *"I feel so much more in control of my life if I have made lists and written everything down. I feel that I can actually sleep better if I am organised." (Participant DF18-11)*
- *"Dyslexia is a disability that requires time, effort and a developed sense of self to cope with. I feel that all children need these skills but those with dyslexia often need help to get there especially if they feel they are disadvantaged (have to work harder, longer than their peers). I think the emotional and motivational aspects are often overlooked. The message still needs to be you have to work at it." (Participant DF45-1)*
- *"I am a born organiser (so I'm told!). Very much set in my routine which is organised by time. Don't like it being upset. Leav (sic) mysegfl (sic) notes of things i (sic) have to do & when to do them." (Participant DF45-3)*
- *"Not enough of it left for all the things I want to learn and do!" (Participant DF45-4)*
- *"I never have enough time to do all the things I would like to do. Personla (sic) observation - people who appear uptight and anxious over time issues often appear to me to be 'busy doing nothing.'" (Participant DF45-5)*
- *"Time goes faster the older you get." (Participant DF45-6)*

Non-dyslexic Females

- *"My boss is ALWAYS late for meetings. I have to constantly wait for her and I get very angry. I feel that she has very poor time management skills and this is VERY frustrating." (Participant CF18-7)*
- *"I very much feel that my attitude towards time management is due to my personality type. If I am not in control of my own time.....I'm not in control!!!! (I have missed out some questions on this form as I feel I would only be able to answer them if I was dyslexic. Hope this is ok?)." (Participant CF18-9)*
- *"There is never enough hours in the day!!" (Participant CF18-12)*
- *"I work in a school which has 5 periods in a day. I do not and cannot remember what time lessons start and finish no matter how many times I have to check during the day and I have written noted (sic) to myself to remind me. This is very frustrating for something that seems so simple." (Participant CF18-15)*
- *"Knowing that you can never have time back is one of the most difficult aspects of life to come to terms with." (Participant CF45-5)*
- *"Time can cause frustration - especially to children with processing difficulties. It would be so wonderful if time were not an issue - if children could progress with their learning and not have to deal with timed tests, but life isn't always that easy." (Participant CF45-6)*
- *"I find it interesting that some dyslexics are not so aware of the passage of time - such as children not being aware of when break time is or lunch and for students who are not clued in to exams timings." (Participant CF45-2*

5.7 Summary – Research Questions Answered

In summarising the analysis of the adult questionnaire, and to explore the hypothesis that dyslexic adults describe finding personal time management more difficult than non-dyslexics, the outcome of the seven questions established in the literature review are presented next.

The first question was: *Will the dyslexic participants refer to greater difficulty with mathematics than the non-dyslexic participants?*

The dyslexic participants reported that they found the primary topics of mathematics (numbers, shapes, trigonometry, statistics, graphs and algebra) more difficult, when compared with the non-dyslexic group. Topics involving visual-spatial processing proved to be more difficult for the dyslexics than for the non-dyslexics. Further, the dyslexic participants described having difficulty remembering and recalling multiplication number facts.

The second question extending the theme of mathematics and time: *Will dyslexics show greater concern for time and aspects of time?*

Both groups when preparing to attend an appointment cited the importance of punctuality. The dyslexic group, however, cited it more often and commented that being punctual helped alleviate the stress they experienced. Moreover, they were the only group to indicate frustration as an emotion. In addition, they attributed greater importance to the politeness and courteousness of their actions. They would make extra effort to be at an appointment well before the allotted time. Further, the dyslexic group also indicated that they would feel angry if others kept them waiting. The non-dyslexic group cited reliability as an important factor in connection with punctuality. It does appear also that in both groups these participants preferred to have some level of routine to maintain their time management.

Time management skills offered the basis of the third and fourth questions. The third question was: *Will dyslexics find personal time management difficult, compared with non-dyslexics?*

A study of day-to-day time management skills revealed, overall, that the dyslexic participants generally appear to show greater difficulty with organising their time. Respondents reported being distracted and experiencing a feeling of being overwhelmed by too much when confronted with organising their time effectively. This research found a significant difference between the dyslexic and non-dyslexic groups with telling time. Further, remembering time phases such as seasons, years, weeks, months, days of the month and dates proved difficult for the dyslexic group. In addition, elapsed time and the 24 hour clock were also mentioned as being challenging. This appears to lead to the problem of remembering events and event dates.

Observations made by some of the dyslexic group of others suggested that some people were "too relaxed" about time management. Of the non-dyslexic group, more referred to rushing to achieve their goals. Interestingly, both groups appeared to prioritise arriving early for an appointment.

In order to manage their time more efficiently, the use of technology was studied, particularly as a means of coping with potentially weaker time management skills, as shown in the fourth question: *Will dyslexics embrace technology as a means of coping with their time management skills?*

Dyslexics do embrace some technology as a means of coping with their time management skills though the evidence proved surprisingly sparse for both cohorts. It was anticipated that references to technology usage would be more widespread and evident. Though this was not the case this might be indicative of the age spread of the participants and not reflective of technology in itself. It was clear though that the dyslexic participants prefer technology that is mobile. This might suggest that the immediacy of this technology is most important to them.

The fifth question asked*: Do dyslexics participants report finding overestimating and underestimating time a challenge when compared with the non-dyslexic group?* This question enabled both groups to consider task planning and the detail to which they may strive to achieve task goals. The outcome would help to establish if dyslexic participants find overestimating and underestimating time to complete tasks a challenge, when compared with the non-dyslexic group. The findings suggested that estimation was a challenge for both groups. Overestimating was cited as the primary difficulty, followed closely by underestimating for both groups. The dyslexic participants, however, seemed to find the processes generally more difficult than the non-dyslexic group. This in part duplicates the results of Nicolson et al. (1995) where the dyslexic groups showed impairment on the time estimation task in their study.

Presentation of timetables to convey complex time related information was thought to be a likely challenge for a dyslexic. It was anticipated that any task involving reading, sequencing, and understanding would manifest a difficulty for the dyslexic group in particular, and so the sixth question was devised: *Will reading timetables by the dyslexic group prove more difficult for them than the non-dyslexic group?* The results appear to support this notion. There are signs from the dyslexic responses that they display less confidence toward reading timetables. They avoid using them and prefer to ask for advice from someone who knows, whenever possible. Further, the more complex the timetable, the more likely dyslexics will avoid using it.

The final question was: *Will dyslexia influence career choice and lifestyle changes?* The results were unclear. For career choice, the dyslexic participants tended to move toward a practical career path more than an academic one, when compared with the non-dyslexic group. It would appear also that a number of the dyslexic participants have made the decision to become self-employed. Equally, dyslexic participants have, in some cases, adopted careers and lifestyles that have avoided coming into contact with their dyslexic weaknesses such as writing, which if present can cause lowered self-esteem. It was stated by some dyslexics that they cope with work demands by bringing work home to progress. Productivity and lack of enjoyment for academic development do appear to influence choice toward a practical career option for dyslexics. If writing is unavoidable, the younger dyslexics have and are adopting technology to help cope with their needs. It was noted also that some of the self-employed dyslexics rely on partners to help with the administrative side of their businesses.

5.8 Overall Summary for Section 2

The evidence supports the hypothesis predicting that time management is more difficult for dyslexic than non-dyslexic adults. There are issues for dyslexic adults in general day-to-day time telling which compounds their problems and leads dyslexic individuals to modify their behaviour in order to cope with their impediment. Dyslexia affects time management through poorer time estimation, time planning, time organisation and time implementation. This appears to increase stress and anxiety and causes individuals to avoid demanding situations.

Chapter 6 Discussion

This discussion chapter aims to provide reasons why dyslexia appears to affect time telling skills in children and time management skills in adults.

There is an observable difference reported between the dyslexic and non-dyslexic groups in both sections of this research. The Time Comparison Task, which aimed to discover if there was a difference in performance for both accuracy and speed, supports the findings of other researchers in mathematics related fields (Andersson 2008; Burny et al., 2011, Turner Ellis, 2002).

The adults, in the questionnaire, refer to the difficulties that they had with learning to tell the time as children, and indicate on a long-term basis that some issues of time telling still pose problems for them. By way of example, timetables, calendar dates and elapsed time appear to impact on their time management approaches which affects their day-to-day living.

This discussion chapter is treated in two parts to enable the independent observations made of the two facets of this thesis to be explored and to draw on the knowledge gained with reference to the literature review. Two models are offered by way of explanation in the context of the research questions, to promote understanding. At the end, the chapter will draw together and compare the relationship with the time comparison task and the adult questionnaire in order to consolidate a common theme to report.

6.1 Time Comparison Task

The research questions presented below, aim to guide the observations of the Time Comparison Task and encompass links with other research in dyslexia and mathematics that were of a similar nature (Turner Ellis 2002).

It was hypothesised that dyslexia would affect the performance of dyslexic children when compared with non-dyslexic children in a Time Comparison Task (TCT). The four research questions in this section focussed on accuracy and speed with an emphasis on group and also age comparisons.

The results of the TCT presented some very interesting findings. The calibre of the participants who took part enabled a clearer picture to emerge of the weaknesses that dyslexia appears to cause in time telling. As this was a time comparison task presented on the computer, each individual tackled the task in their own way and the observations made by the author were of students who tried to perform in the best way that they could. The rigorous nature of the preliminary screening enabled careful selection of participants for the experiment. Their time telling skills were unknown, though it was assumed that their knowledge, based on their exposure to the three Key Stage levels of mathematics teaching, was sound. This meant that the choice of mixed time questions randomly selected provided a thorough measure of participants' skill across the three age bands and the three complexity levels.

For the TCT to measure performance, participants compared analogue time presented against a digital time in a way that enabled scrutiny of accuracy. This of course varied between the three age groups, given their level of expertise in the time telling discipline. The strategies adopted by individuals, therefore, were likely to differ given the improvement of skill as time telling became more efficient. The evidence from the reaction time and accuracy data supports the notion that both dyslexic and non-dyslexic groups improved in skill as participants matured. This finding is analogous to other researchers' studies of time telling (Burny et al., 2011; Friedman & Laycock, 1989) verifying that skill improves with age.

If the non-dyslexic participants are the "measured benchmark", what is evident is that their performance appears to show a reasonably linear skill development for reaction time between seven years and fourteen years of age. Given that the analysis of the seven year olds considered the simple clock times only, their overall accuracy was appreciably different from the lowered performance of the dyslexic group of the same age. Improvement of accuracy continued for the non-dyslexic group by age eleven and continued, though slowed, by age fourteen. The eleven year old controls improved on their accuracy by 13% between the ages of seven and eleven. This trend was anticipated and in accordance with the trends of other researchers (for example, Burny et al., 2009; Turner Ellis, 2002) though the comparison cannot be directly made as the seven year olds' performance was measured against simple clock times only, whereas the eleven year olds' performance was measured against the three complexity times. The improvement made by the control group in accuracy concurrently occurred with reaction time improvement, showing that although the complexity of the time became more challenging, their reaction time and accuracy improved. This measurable improvement can be attributed to a number of factors. To respond at speed and to be close to 100% accuracy, time telling mechanisms are functioning at expert levels of recognition, automaticity and cognitive dexterity.

Recognition of the two times (analogue and digital), involving their appearance, rapid processing and response, requires rapid retrieval from memory of the information, such that it is most likely by age 14 years to be an automatised skill. The automatisation might include sub-vocalisation of the time, though the researcher recorded no observable ‘chatter’. Automatisation is paramount for rapid response and to achieve automatisation, practice and memory function are essential. By way of reminder, the non-dyslexic group were of marginally inferior on the Raven’s IQ scores to the dyslexic group, though in the average range. Therefore, it is logical to judge their skills as representative of the average non-dyslexic population.

However, the dyslexic group’s performance was noticeably dissimilar with the overall reaction time and overall accuracy being substantially weaker than their non-dyslexic counterparts. When considering the seven year old group, it was reported in the results that their reaction time response was very different from their non-dyslexic counterparts and so the results were not analysed further, though it should be noted that the dyslexic group were 36% accurate on simple clock faces only. When considering the two older age groups, however, the trend for poorer accuracy and slower reaction time remained evident, though by age fourteen the dyslexic participants had shown marked improvement in accuracy with a more gradual improvement in reaction time. Indeed, the reaction time at eleven years old for the dyslexic group was only one second slower than that of their non-dyslexic counterparts, but this was mediated by weaker accuracy (65%), compared with the non-dyslexic group (88%). The improvement which was most evident was that of accuracy by age fourteen; the dyslexic group had improved in reaction time by barely one second, though their accuracy had improved by 20%. Moreover, the dyslexic fourteen year olds remained slower, by three seconds in response, when compared with their non-dyslexic counterparts, and continued to be less accurate (by 6%). These findings support the notion that the dyslexic participants require much more time to process the information presented, to provide an accurate answer.

Given that the dyslexics were of higher intellectual ability, and yet presented performance statistics of this nature, it seems that dyslexia is likely to be affecting execution. Why that might be the case is open to conjecture and would require further analysis specifically connected with the mechanics of the task, perhaps to include measurements of eye movements for instance, or by asking individuals questions connected with their approaches. Though this may provide additional factual and anecdotal evidence, it may also prove inconclusive.

What is clear is that the automaticity of retrieval resulting from rapid recognition, processing, naming and response, as so eloquently demonstrated by the control participants, is lacking in the dyslexic group. Other research in mathematics and time telling skills of dyslexic children highlights difficulties in rapid retrieval of number facts when carrying out problem solving (Jordan et al., 2003; Siegler & McGilly, 1989; Turner Ellis, 2002). In addition, they may find difficulty with procedural processes and mathematics language (Burny et al., 2011; Geary & Hoard, 2005).

Evidence from this present research on the improvement in skill level is demonstrated for the dyslexic group, which would support the notion of analytical processes improving with greater automaticity. This is confirmed by progress in speed and accuracy, inferring that retrieval techniques are also developing. To be exposed to a particular time and to do a comparison against another time requires individuals to be able to assimilate the information quickly.

The strategy in answering the time comparison questions does appear to differ between the dyslexic and non-dyslexic groups. If improved automaticity represents developed retrieval skills then the scale of the difference in performance highlights underdeveloped automaticity amongst the dyslexic group compared with the control group.

When considering the knowledge gained at age 11 years, according to the National Curriculum, by this age students have been taught time to the nearest minute. Let us consider, therefore, the predicted approaches. At this age, knowledge of the simple time such as those times on the hour, quarter past, quarter to and half past, will have been the most practiced group of times, followed by times at five minute intervals and finally one minute intervals. Other researchers corroborate this likely schema (Burny et al., 2009; Friedman & Laycock, 1989) confirming that analogue time telling is showing mastery at around this age.

The author believes too, that by this stage, the plethora of language attributed to analogue time telling is grounded and that this helps in overall time telling. This ability is evident in achieving communication of time to a third party (Korvorst et al., 2007). Certainly, as other researchers have stated, knowledge of digital time should be well established (Burny et al., 2009; Friedman & Laycock, 1989). If this is indeed the case, then it would seem reasonable that digital time be the starting point in this time comparison task. This is borne out by the finding of this research in that an interesting anomaly appeared amongst the dyslexic responses. Results showed that the dyslexic eleven year olds were able to respond to mismatched times better than their non-dyslexic group counterparts. This could be explained by the dyslexic participants observing the digital time first before comparing that time with the simultaneous analogue time. This strategy would enable a faster comparison to be made. The digital numbers may also have been isolated to the minute value of the analogue clock first, without needing to consider the analogue hour time or vice versa.

Though both groups might have approached the task in the same way, there may have been a subtle difference. Given that the task was timed, and that the dyslexic group was weaker, the dyslexic approach may have been more selective. Perhaps the ‘whole’ analogue time was not considered against the digital time. Instead only part of the digital time was compared against the analogue clock face without fully analysing the question. Thus, reaction time would have improved but accuracy would have been affected. This ‘shortcut’ would release memory hungry resources such as retrieval and possibly vocabulary to improve processing speed. This procedure could equally be appropriate for the non-dyslexic group and explain why their reaction time and accuracy scores remain consistently better than the dyslexic group whereby they are able to absorb more of the detail.

From the author’s experience, digital time was always preferred over analogue time, as a more ‘accurate’ measure. It offered preciseness and assurity when time telling of the analogue clock became challenging, particularly as the analogue time could be rounded in explanation from what was displayed. It seems rational, therefore, that the dyslexic cohort in this research would have adopted similar strategies.

It was anticipated in the original design of this experiment that the quartiles of the analogue clock might present a challenge in accordance with the findings of Hari et al. (2001), whose work on mini left neglect in the dyslexic profile might be evident. However, as was reported in the results chapter, mini left neglect was not apparent in the result findings for the quartiles of the clock. This might suggest, therefore, that the digital time was considered in advance of the analogue time by default. If this was the case, then the comparison with the analogue times could be assessed quickly. Where there was doubt in choosing an answer, the processing skills required resulted in a more concrete approach to time telling, such that the children may have used known anchor points to progress the analysis of the question toward a suitable answer. These approaches may have been more relevant in the older cohort rather than the very young participants and the benefit of continuing repetition in time telling is likely to have improved the skills of the older dyslexic participants, as confirmed by improvement in accuracy. Further, and this is more speculative, with mini-neglect in mind, perhaps the left digits (hours) were missed when reading the digital time, thus focus concentrated more on the minute digits only.

On this basis, and with developing knowledge, the older children were likely to retrieve time telling facts and recognise the analogue clock times much more readily as a result of improved memory for the information. It is only on questions which were unfamiliar or more demanding where the author believes the children would respond by adopting more procedural methods than retrieval strategies. This, of course, would rely on sound procedural knowledge in advance of the question. Any deficit in the procedural relation is likely to cause children to adopt a different approach such as guessing, for instance, based on whatever information is readily available. In the circumstance of this experiment, the children did not have the benefit of support and guidance of a teacher to reinforce the correct answer, so the time taken and the procedures adopted would very much have relied on previous knowledge. Of course, the researcher did not know the level of skill that these participants had previously attained, so it is difficult to judge specific improvement areas.

Nevertheless, the response to all these questions was measured under timed conditions, which might have affected the dyslexic participants more. Although the candidates were aware that the computer was measuring their response time, little is known if the children felt additional pressure as a result of working under timed conditions.

For improvement to be observed in an individual who is learning a skill such as time telling, the criteria for measurement may vary in the mind of the participant. What was observed was that the reaction time of dyslexics by age fourteen, although improved, had not improved to the same extent as their non-dyslexic counterparts. Nevertheless, the accuracy with which they responded, does suggest that the dyslexic participants were keen to present what knowledge they had. Thus, improving accuracy performance was achieved with little reaction time improvement. This result does suggest that there was a speed/accuracy trade-off, though to confirm this, further independent research is needed. After all, whether this result can be described as a speed-accuracy trade-off is open to debate and may simply be an observation of improved time telling skill. It is the author's belief that the slower reaction time performance links with processing deficiencies resulting in changes to the way dyslexics tackle the time comparison task. This may provide the evidence to show that slower procedural approaches are adopted when rapid retrieval of knowledge is lacking.

What is unclear, too, is the role that time telling vocabulary had in helping the children with this experiment. As a method by which cues are sought, the use of similar vocabulary as cues for spelling is widely known (Tallal, Miller, & Fitch, 1993) and acts as an additional means of achieving success. The complex array of vocabulary is presented next for discussion.

That dyslexics have difficulty with paired-associate learning has been researched and discussed by Ackerman and Dykman (1995), Done and Miles (1978, 1988), Vellutino (1979), and Vellutino, Steger, Harding, and Phillips (1975). One such paired-associate learning task was to present the participants with nonsense shapes for which novel names had to be learned (Done & Miles, 1978). When naming, the dyslexics needed to have the pairings presented on more occasions than the controls, before learning had taken place. In addition, dyslexics were shown to have longer response latency where they took longer to produce the right word in naming real pictures (Done & Miles, 1988). Related to this research, the youngest dyslexics had not yet learned pairing the analogue time representation to the digital representation, particularly for the intermediate and complex times. According to the findings for paired-associate learning, they would need many more pairings of time to vocabulary, and pairings of complexity levels and multiplication fact situations (with the five times table) before they were adequately proficient. In this current research, the time questions were presented visually and it is presupposed that the participants relied on a visual-verbal association to determine the answer. For less well-rehearsed times (e.g. the simple times) this might be the case, but for other times it may be much more procedural.

T.R. Miles (in Miles & Miles, 1992) emphasised that dyslexic weakness at paired-associate learning was not applicable to the learning of all associations, but more particularly to situations that require the understanding of symbols (and hence verbal labelling). The processing of linguistic material places the dyslexic in a disadvantageous position because of a deficiency at the level of lexical encoding (Ellis & Miles, 1981). Ellis and Miles (1981) used a model of an internal "dictionary" (lexicon) to explain how we learn to talk. New words are entered into the dictionary in the lexicon, and these are retrieved from it when words are spoken correctly. This theory encompassed the deficiency of dyslexics in naming visual stimuli (i.e. accessing and retrieving words from the lexicon). Thus, a lexical encoding deficiency provides a possible explanation why dyslexics form fewer entries in their internal lexicon for number facts, time and vocabulary links.

Figure 6 serves to illustrate the complex array of vocabulary needed to master the "language" of time to which all children are exposed during their school career. Understanding terms, retrieving terms, manipulating and processing terms requires solid grounding to accomplish successful procedural maturity.

For the dyslexic cohort, more time was needed to achieve a similar accuracy level as for non-dyslexics.

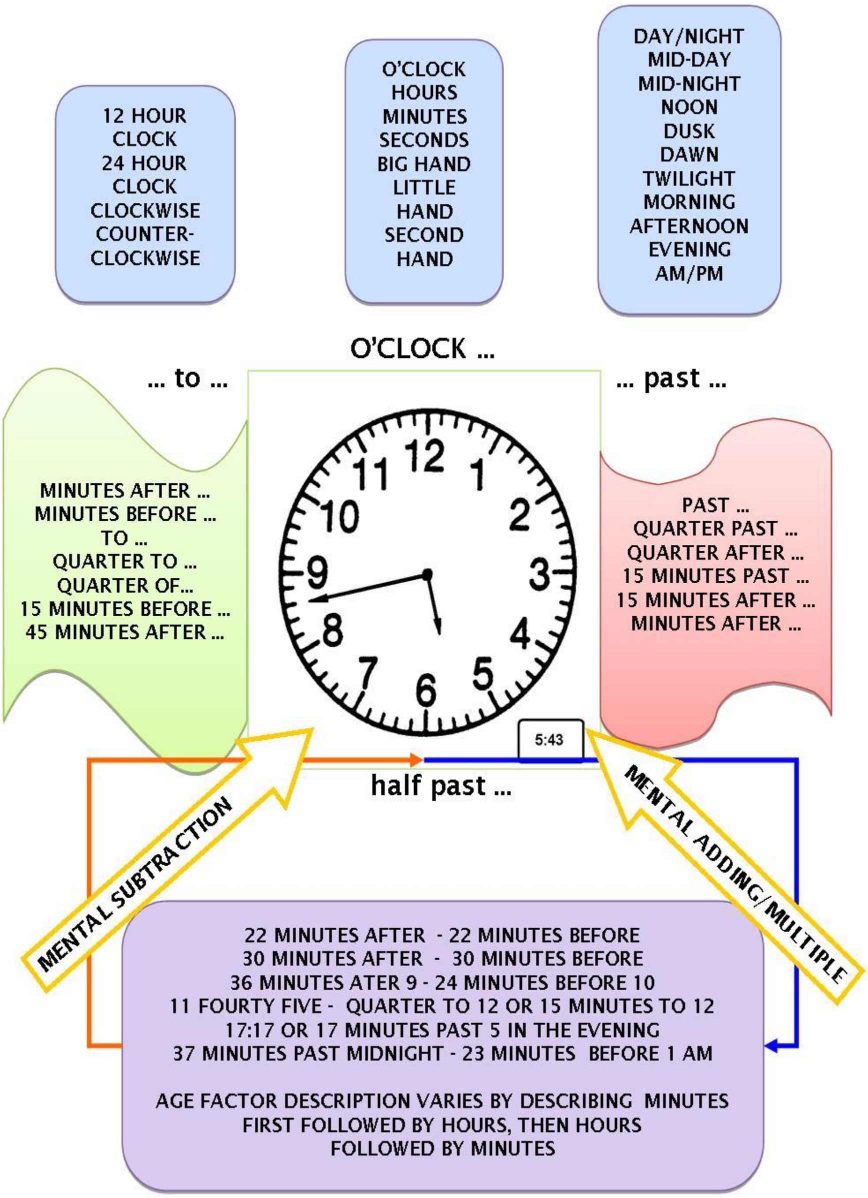

Figure 6: Time Telling Vocabulary

The author believes that the pairing of vocabulary and times is equivalent to the learning of a second language in complexity, understanding and syntax. If the participants require this vocabulary to initiate time telling, then the dyslexic children would be at a distinct disadvantage. The retrieval process might in some cases be so difficult that by adulthood some dyslexics still struggle with acquiring the skill.

Further, despite the greater number of “exposures”, the dyslexic is slow to pick up the familiar (Miles, 2002 – personal communication) as shown by the dyslexic difficulty in learning the correct sequence for the months of the year; a sub-item in the Bangor Dyslexia Test (Miles, 1982, 1997). Miles writes of two main factors influencing the learning of information like the months, namely, how often it is practised and the length of the series to remember. If number facts are numerous and unrelated and patterns within the mathematics are difficult to register, then more resources are required which differ between the dyslexics and the non-dyslexics. Therefore, the young dyslexics in this research were particularly slow to pick up the most familiar time facts. Thus, in the young age band the dyslexics may not have “absorbed” (Miles et al., 2001) as much as the controls.

In summary, the outcome of the Time Comparison Task portrays a convincing outline of the difficulties experienced in time telling by dyslexic children. The results show that dyslexic children do improve their skill with age, and that they adopt approaches which are different to their non-dyslexic counterparts. The results show too, that when a question is difficult for a non-dyslexic, it is likely to be appreciably more difficult for the dyslexic.

6.2 Child Model of Time Telling

The child centred model of time telling for the Time Comparison Task experiment in Section 1 is presented in Figure 6.1. It constitutes the retrieval type strategies used to allow rapid time telling and depicts the likely approaches adopted by dyslexic and non-dyslexic children when learning to tell time. It was decided that a model could be designed and would be the best way to convey the complex processes of learning to tell time. The adoption and implementation of three primary strategies, the author believes are used to tell time, change as children mature.

The developmental progress made by the dyslexic and non-dyslexic cohorts in this experiment can be followed through this model. The progression longitudinally across the three age groups in time telling relies on learning the mechanics of time telling, and enabling the evolution of vocabulary and visual aspects of time to be absorbed by individuals. This clock comparison experiment is founded on recognising time in two formats and, to achieve this, there is a requirement to learn many longitudinal links over time. This model presents a depiction of that development and how children hone their time telling skills. The differences between dyslexic and non-dyslexic approaches are presented and explained.

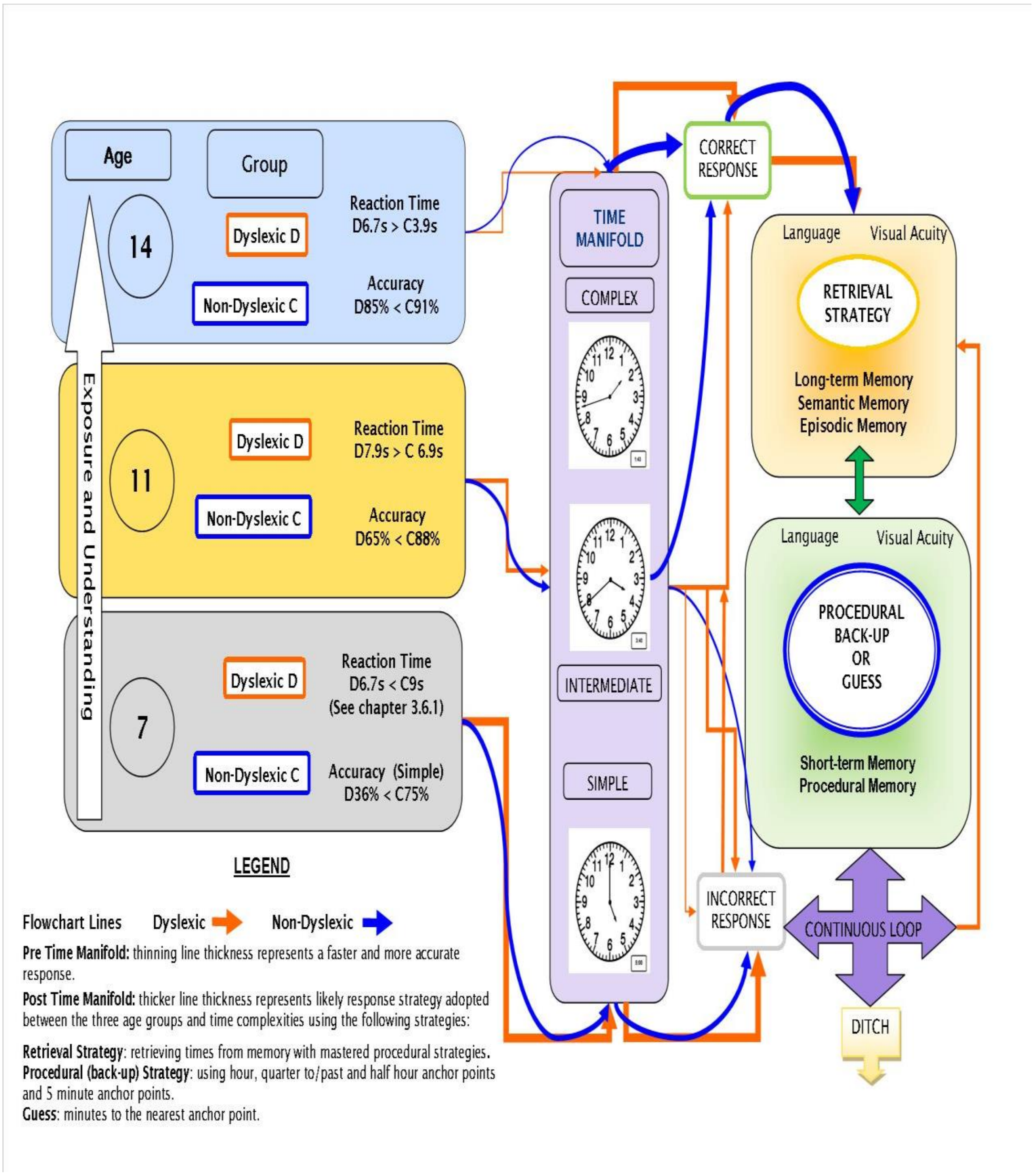

Figure 6.1: Child Model of Time Telling

This model is presented as a flow diagram and is read from left to right. At the left-hand side of the model, the age of the participants from seven, 11 and 14 years old is presented. It can be seen that as age increases, then potential time exposure, practice and understanding also increases, so that at 14 years of age both the dyslexic and non-dyslexic groups are mastering time telling with better accuracy and also speed. The thickness of the flow lines represent the improving situation by the participants, where the thinner the line the faster and more accurate the overall response. The arrows signify the direction of developmental skills. The average reaction times and accuracy measures are presented against the three age groups to enable the reader to appreciate the ‘scale’ of improvement made by the children.

The *Time Manifold* in the middle represents the three clock time complexity levels as measured in the experiment. The times depicted are examples of how they look to a child reading them. The flow lines entering the manifold from the left are thickest for the seven year olds, are thinning for the 11 year old children, and are thinnest for the 14 year olds. This symbolises that speed and accuracy performance in the experiment improved with age.

Beyond the *Time Manifold* and to the right, there are two response junctions (labelled Correct and Incorrect) that exemplify the outcome of choosing an answer and time telling strategy. Next, the three strategy options are presented to illustrate developmental skills. Correct responses are allotted to the *Retrieval Strategy* reservoir where future fast retrieval can be performed on any times presented, as individuals are more expert and automatic in their abilities. The author believes this expert level integrates semantic and episodic memory in support of long-term memory storage to improve accuracy and speed of response. There is a transitional link between the *Procedural Back-up or Guess* reservoirs that bridges short-term memory and procedural memory toward a retrieval approach. Any incorrect answers follow the *Continuous Loop conduit* or are *ditched* so that through repeated exposure the responses become more accurate - to be finally gathered in the retrieval reservoir.

In the school environment, the different complexity levels of the clock are presented and controlled for as the topic is taught. While considering time telling, children may opt for three possible strategies and these are based on exposure, understanding and memory for retrieval. It is likely that there is a difference between individuals during their learning experience. The phases of development are clear though and the findings of this research suggest that some children appear to gain understanding sooner than others.

The phases are as follows:

1) The first phase of time acquisition is *guessing.* Where a child lacks knowledge, guessing at the answer is adopted as mental resources are challenged and guessing offers the easiest option.

2) The second phase is based on *procedural* (back-up) strategies. Here children are taught more complex time scenarios to build on skill development. This may involve the use of known anchor points from which to navigate. The anchor points could be the hour, quarter past, half past and quarter to, followed by minutes in groups of five or in ones to establish the time asked. Mental resources are improving, enabling some retrieval, with the added benefit of refining procedural approaches. Responding accurately at speed advances with this method and levels of expertise develop to reduce the need for the guessing strategy.

3) The third phase is *retrieval*. Here the time is known and the knowledge is retrieved automatically from long-term memory. This method is faster to implement but requires 'sound' understanding of time telling and immediate recall from memory of the time presented. In this circumstance, the individual is confident that on appraisal the time is "what it says it is". This phase indicates mastery of the skill to expert level and enables mental resources to be redistributed elsewhere and for response times to diminish.

It is apparent that if a time is difficult for a non-dyslexic to read then it is likely to be even more difficult for the dyslexic. This has been shown with the dyslexic underperformance both in speed and in accuracy when compared with the non-dyslexics counterparts. The fundamental question is why?

Depending on the progress made and the success with the topic, the researcher believes that students with no learning difficulty will progress naturally through these three phases without too much trouble, as verified by the control group performance. The vocabulary associated with time telling will help to reinforce the perception and recognition of time and vice-versa, and the feedback given by the teacher will enable the student to gain in confidence when the answers are correct. With a correct response, the time is logged in short-term memory where it is acknowledged, remembered and sent to the long-term memory for future recall as a correct response. In the case of an incorrect response, the answer migrates in the same way from the short-term memory but deviates toward a back-up strategy or a guess that is employed to seek the correct answer. When the answer is correct, this knowledge passes to long-term memory in the same way for later retrieval.

Further, if the time given is significantly awry and none of the back-up strategies have worked then the answer is discarded.

From analysis of the results, the processes adopted in learning time appear to be varied. As time is taught, it is clear that memory is a key component in helping formulate the recognition and recall of time, enabling the link between what is seen, the associated vocabulary and subsequent translation, into meaningful understanding. Therefore, as a large component, any limitation in this mechanism is likely to affect the outcome. Consequently, memory appears to be a very important factor.

The researcher believes that the language used to describe a clock and the visual perceptual problems encountered, pose little difficulty for the non-dyslexic student. In contrast, for the dyslexic, although the visual acuity may be fine, the language support and the flow between short-term and long-term memory may be compromised. Under these circumstances, as the complexity level of the clock time increases, differentially greater demands are placed on the dyslexic student to retain the time long enough in their short-term memory to recall it using a retrieval strategy. Recall for the dyslexic is known generally to be weaker (Ellis & Miles, 1977). This short-term memory overload, inhibiting a retrieval strategy, will cause the dyslexic to be more inclined to use a back-up strategy. Further, as the language used to describe time is potentially complex, any support it may provide for the non-dyslexic in delivering a fast and accurate response is unlikely to be the case for the dyslexic, without substantial overlearning. Thus, it is seen by the dyslexic as being a highly demanding process.

In summary, the researcher believes that it is the impairment in short-term working memory and long-term memory coupled with semantic and procedural memory which has an impact on dyslexic individuals (Burny et al., 2011; McLoughlin et al., 1994; Turner Ellis, 2002). This, together with weaker vocabulary skills and processing, makes learning time more challenging. Further, as working memory only operates over a few seconds and guides decision-making (Moulin & Gathercole, 2008); the plethora of information presented in time telling becomes overwhelming for the dyslexic.

Overall, this model has been devised to provide a clearer interpretation of the outcome from the results of this research in order to afford better understanding, prediction and control. It is designed to offer a schema for individuals to follow which will help practitioners and parents alike to understand the mechanisms involved in successful time telling.

6.3 Adult Findings

Dyslexia is a lifelong condition, and it appears that coping strategies are being continually developed by dyslexics to help with day-to-day time management. The evidence of weaker performance by the dyslexic children reported in Section 1 is likely to affect performance in adulthood, due to the impact of slower processing speed and weaker memory which has an effect on overall time management performance. Moreover, any weaknesses that continue to exist may stubbornly remain for some time later. A number of reasons for this might exist that include a lack of practice, as a result of no longer being exposed to an academic environment from childhood, or a lack of confidence, due to weak time management processes which are not very effective in adulthood.

The adult dyslexics reported that they had difficulties with time telling as children and so it seems logical that their difficulties might be of a similar nature to that of the dyslexic children in the time comparison experiment. The evidence sought in the adult questionnaire was to determine if dyslexic adults still had difficulties telling time and how that manifested itself in their day-to-day time management.

As a prospective tool, the questionnaire enquired about mathematics and time learning difficulties in childhood, which may evolve and contribute toward time management problems in adulthood. Evidence from the questionnaire highlighted that some mathematics difficulties were reported in accordance with those described by other researchers (Turner Ellis, 2002; Miles et al., 2001), for example, in the case of difficulty with multiplication number facts causing challenges in school.

In time telling as children, the dyslexic adults reported that they had difficulties with seasons, months, days of the month, elapsed time and timetables as well as some time telling issues. This supports the evidence from other research (Miles, 1983) where observations of temporal understanding in dyslexics appears weaker. Friedman (2007) referred to temporal difficulties of children and adults in a study of time estimation. Though the participants were not reported to exhibit learning difficulties, Friedman wrote that they found it difficult to make temporal judgement of an event time. This observation might, therefore, be more pronounced in children and adults with dyslexia. A small-scale questionnaire by Cousins (2003) given to participants with motor control difficulties, reported significantly that they had problems with keeping timed appointments. The explanation for several of these difficulties may point to long-term memory weaknesses. The skills learned with some of these temporal concepts contribute directly to skill development in time management used in adulthood. The time management approaches, however, are very personal and thus rely on self-concept to be successful.

What has been reported by the adult dyslexic participants in this research is that timetables and time management can be problematic. Reference is made to the difficulty that dyslexic people have in keeping track of what they need to do and it appears that in some cases they are reluctant to use mechanical time management principles such as writing in notebooks or diaries. However, some researchers (Kirby et al., 2008) have found contrary evidence whereby in university, dyslexic students are reporting a positive use of TM strategies including mechanical TM and technology to help with their organisation and their courses.

The participants in this present research are from a mixed array of backgrounds. Therefore, the ethos for adopting strategies used amongst a homogeneous group at university is likely to be different. Task demands and TM principles are likely to be taught and shared at university and so might differ from solo approaches adopted by individuals in the workplace, who may have devised methods for themselves without the benefit of teaching. Certainly the author concurs with the latter from personal experience and with the former as an important skill to teach. A number of older students taught by the author have said how useful some TM tools have been, such as *Outlook* software, mind mapping software and SQ3R (see section 4.3 in Chapter 4). These approaches have helped them to cope and some have reported that they only used these tools at university and not before and wish they had.

The role of time management in organising a task is acknowledged to be very important (Strickland & Galimba, 2001) and the processes adopted appear to vary amongst participants in the adult research. The use of mechanical and technological support tools was seen as a means of achieving improved assistive mechanisms as it appears that the use of diaries varied more amongst the dyslexic participants than non-dyslexics. What has been stated is that poor planning leads to an increase in levels of stress, which is reinforced by the author's experiences. Therefore, in order to control the planning processes better, it was anticipated that technology would be used more widely. However, this proved not to be the case and though technology is used, it appears to be less important in time management planning. It was stated though by one or two dyslexic adults that the mobility of technology in the form of phones, etc. did enable them to keep a closer management of their time. It was reported too, that where technology is used, it helped to control time sensitive processes, thus allowing more to be accomplished and less to be missed. Audible alarms for example, helped to remind individuals of events and this had the positive effect of helping them to feel more in control and making them feel better.

One apparent aspect of time management is that in adulthood individuals are expected to be much more independent in the way they manage their time. In the case of dyslexics this aspect might be unfamiliar. This would link in with time telling difficulties in childhood such that, at this time, parents are likely to be responsible for organising the day-to-day time management of their children. Under these circumstances, the responsibility is lifted from the child. However, depending on how independent the child becomes, then greater responsibility is devolved as they grow older. It is only then that children are likely to feel the greatest ownership with organising their own time and any weakness in time telling could potentially undermine this confidence. As a result, this lack of confidence is anecdotally made reference to by some of the dyslexic participants in this questionnaire. Some acknowledge that they use others to help organise their time, and in particular their spouses. This leads the researcher to the conclusion that time management is much more challenging for these individuals than was expected.

6.4 Adult Time Management Model

To better understand the time management approaches adopted by dyslexic and non-dyslexic adults, a model is presented in Figure 6.2. The anecdotal qualitative and quantitative evidence from the questionnaire responses is combined with the knowledge gained from the literature review into a flowchart representation, which best fits the methodologies adopted by adults to organise their time.

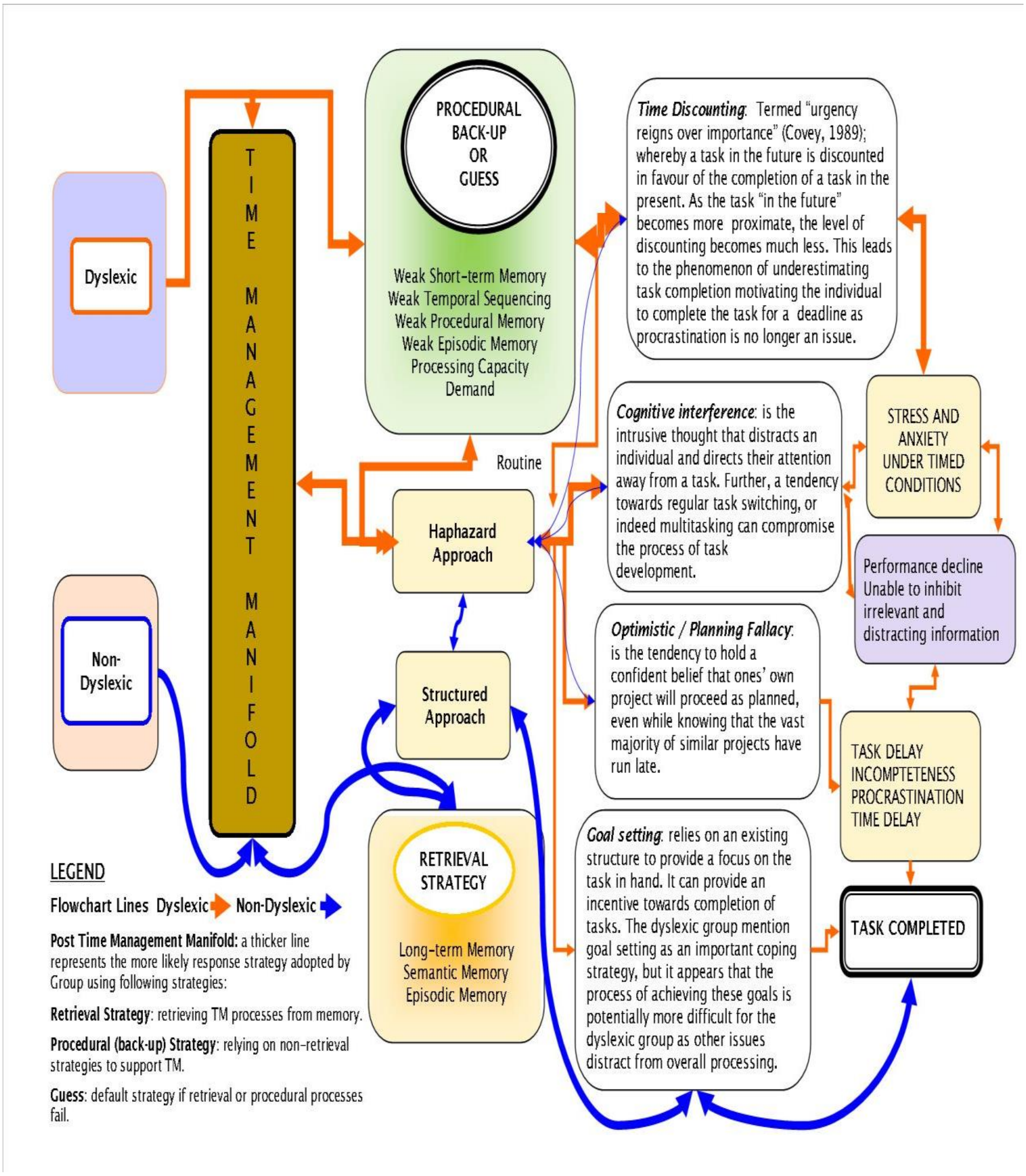

Figure 6.2: Adult Time Management Model

The flow lines are colour coded to differentiate between the two cohorts, with orange used for the dyslexic and blue for the non-dyslexic. The thickness of the line depicts the likely weighting placed on the sequential processes that take place. The thicker the line, the more probable the strategies embraced. The arrows show the relationship between aspects of the model.

The adult population in this research have been most enlightening when answering the questionnaire. From the anecdotal evidence provided by them, it appears that the dyslexic cohort adopts a more procedural or back-up strategy than the non-dyslexic group, where this supports the approaches used in the Time Comparison Task in Section 1 of this thesis.

The reasons for this behaviour emerge through comments made to a number of the questions. A common thread of deficiencies in time management processes governs the way the dyslexic participants behave. It would seem that their time management appears more haphazard when compared with the non-dyslexic group. The dyslexic group report that they do not time manage and in some cases "fly by the seat of their pants". In these situations the author was interested in establishing a legitimate reason for this kind of behaviour and to discover if it was commonplace amongst the dyslexic participants.

This is most evident when individuals are presented with a number of tasks to be carried out consecutively. Demands placed on time management of the various projects causes changes in the way adults appear to cope. What has emerged is that time management principles, where they appear to be difficult to adopt, have not been readily adapted to the unique approaches that the dyslexic adults appear to show. When questioned further, it is reported that urgent tasks are tackled more often than important tasks, which was characteristic of a typical time discounting profile. The evidence to support this notion was that these individuals find time estimation of tasks difficult and so lack confidence in decision making / planning.

An important reason for this kind of behaviour is that dyslexics appear to be susceptible to cognitive interference. That is, that they become more distracted, causing interruption of thought. This is most obvious when a number of tasks are performed in conjunction with one another, whereby attention switches between one task and another causing an interruption which manifests itself in a poorer profile of task estimation later on. Though it appears that this circumstance is reported to a lesser extent by the non-dyslexic group, the mechanisms available for the dyslexic group appear to be more restrictive to enable decision making to be adapted; hence task progression is pursued through urgency and not through planning. Described in this way, the profile of AD(H)D – that of flitting from one task to another in an attempt to keep everything working together – comes to mind. However, the author believes that dyslexics are more affected by distractions through the nature of dyslexia because of weaker processing and memory skills. Also, to rebound from those distractions takes more resources from memory. The tendency, therefore, is to forget where in the task process one is, particularly if no note of position is made. With poor organisational and temporal skills to rely on from memory or procedure, the “safest” strategy to remember is one of carrying out the urgent tasks first.

The perception gained of task completion, therefore, becomes erroneous and the task becomes difficult to plan when cognitive interference is prevalent. Given this scenario, individuals tend to view tasks differently, resulting in preferring a more optimistic estimation as a means of regaining control in the task. This optimism is known as planning fallacy where, despite evidence to the contrary with previous similar tasks, individuals have a confident belief that the current task will be completed in the timeframe allowed, even when they know the timeframe is unlikely to be achieved. Although this fallacy is not unique to the dyslexic participants, the effect of poor time management and a haphazard approach is likely to compound the issue, resulting in greater effort required to maintain progress with the task.

For estimation to be successful, knowledge of the task in hand is paramount and experience from past and similar processes helps to hone the decision making for any task. Though it is acknowledged that time estimation proves difficult in many industries and that the end result is that projects are completed beyond the time allotted and over budget, the author believes that the day-to-day time estimations for dyslexics follow a similar pattern. This stems from and is supported by the questionnaire analysis where it is suggested that weaknesses in memory processing, whether this be procedural, episodic, or temporal, contributes toward the difficulty dyslexics have in time management and time estimation. It should be acknowledged, however, that both dyslexic and non-dyslexic participants reported difficulties with overestimation and underestimation of task completion so this was a challenge, but a challenge highlighted more by the dyslexic group.

It seems logical that presented with a new task, individuals would compare procedures with similar tasks as a means to provide backbone to the task structure. However, it is the researcher’s belief that dyslexic people, although able to remember sequences of events to complete a familiar task, are not able to apply temporal markers as accurately as non-dyslexics because of this memory difficulty.

It is noted from responses by the non-dyslexic participants that they set and achieve goals as a means of accomplishing task completion. There was no mention of planning fallacy as an issue though it is likely that they experience cognitive interference and also time discounting to a lesser extent. Goal setting by the dyslexic group appeared to be more of a desired objective but one which was not as automatic in procedure. This may be attributed to a combination of factors culminating in a lack of confidence to make accurate judgements.

The conclusion of poor time management, time discounting approaches, continuous cognitive interference and planning fallacy reinforce a haphazard approach which becomes difficult to control for dyslexics. Consequently, it is the author’s belief that tasks become delayed, or may be abandoned in private task development, though this might happen less with tasks involving organisations or groups. What was reported was that the weaker time management approaches adopted by the dyslexic group appear to increase stress and anxiety levels which are exacerbated when put under time conditions. These time conditions could be affected by poor time estimation, resulting in the negative effect of increasing stress.

This difficulty in time estimation may well be outside the control of the dyslexic participants, however, aspects of time management that they can control present a different outcome. When asked questions relating to time management in the form of punctuality, many of the dyslexics commented that they made every attempt to be as punctual as they could be, and they cited examples of being “over punctual” by arriving for appointments well ahead of time. This idiosyncratic punctual behaviour could be connected with poorer estimation of the time taken to get to an appointment and an inclination toward politeness of behaviour. This difficulty might be characteristic of weaknesses with other temporal judgements such as elapsed time or date and time phases, in relation to their comments made of childhood learning. This researcher believes that this leads dyslexic individuals to take a more cautious approach and regard their own time as being less important. This relates to self-esteem issues which are reported perhaps through lack of confidence, whereby, issues are compounded and the only remedy is to become over punctual and redress control. This type of behaviour shows similarity with the conscious compensation hypothesis devised by Fawcett and Nicolson (1994), whereby to disguise dyslexic difficulties with automaticity, individuals work harder.

One interesting observation made by some of the dyslexic group was that they could not understand how some non-dyslexics around them could be so blasé with their attitude towards punctuality and time management. It does seem that dyslexic adults observe and compare the behaviour of others and have noticed their time management and punctuality behaviour is different to non-dyslexic individuals. There is no evidence from the responses in the questionnaire to suggest why they feel this way, though they acknowledge noticing a difference. Certainly, from personal experience, observing others coping with numerous tasks at once when one task alone is a challenge, is noticed and leads to curiosity as to how such coping is achieved. Frustratingly, this is particularly apparent when the one task the dyslexic has to do seems to be more challenging despite being on par with another person's task; however, the other person appears to be better organised to achieve many more tasks simultaneously. This was most apparent for the author when he was at university coping with the demands of an intensive multifarious course with strict time deadlines to achieve. It was observed that others apparently coped with this situation with ease, while the author found it to be challenging, which impacted on personal feelings of self-esteem and confidence.

The final sections of the questionnaire gave individuals a chance to describe their career paths and their choice of career. This was to establish if dyslexia affected and how it may affect career choice among the participants from a time management perspective. The results support the findings of other researchers that the dyslexic group have tended to steer their careers more toward practical activities rather than academic ones (Taylor & Walter, 2003). The reasons cited are numerous and refer often to reducing contact with writing and reading. Such tasks are often time consuming and impact on smooth TM principles. Interestingly though, reference is made toward the education system being perceived as discriminating against dyslexic learners because, to follow a more academic career, higher qualifications are required and these appear to be more difficult for them to achieve. Some dyslexics who are determined to gain those qualifications report that they often resit examinations. Furthermore, a preference towards self-employment is revealed by the dyslexic group as a way of controlling the way they become involved with work, control time management and reduce stress.

In summary, dyslexia does present challenges among the adults surveyed for this research. The dyslexic participants seem to experience difficulties with their time management as a result of a number of factors and it is likely that some occurrences are derived from childhood difficulties such as time telling, elapsed time, processing speed, memory and retrieval. The dyslexics cope with their challenges in a number of ways, such as through avoidance, with technology, and with guidance and support from others. One aspect is clear – they have shown much determination and forethought in attempting to overcome their problems.

It is hoped that this research project will help in the wider understanding of dyslexia and how it impacts in daily life, education and the workplace.

Chapter 7 Conclusions

The conclusions to this research are presented as the thesis is organised, with the Time Comparison research first, followed by Adult Time Management.

7.1 Time Comparison Task Critique

Having now conducted the Time Comparison Task and reported the findings, the following points emerged by way of critique. The experiment was thorough in participant selection to demonstrate that the dyslexic performance in both accuracy and reaction time differed from that of their control counterparts. The methodology was efficient and the experimental design challenging enough to gain a clear representation of skill development across Group and Age. However, a number of improvements could have been made to help hone time telling understanding and to enable a clearer portrayal of strategies used by individuals in improving time telling skill.

- Although the scope of the research was designed to test particular hypotheses and answer specific questions, it might have been interesting to ask the children verbal questions in a formal and structured way, as part of the data gathering exercise. However, logistically the time management of this would have been more difficult for the schools to orchestrate.

- Such questions might have been about where the participants started on the Time Comparison Task, by way of referencing around the clock face in comparison with the digital time, and also how they went about telling the time (the actual mechanics). Such information would have helped to support the evidence gained from the data output and analysis. Such questioning would have provided documented proof at the time of testing, while the task processes were fresh in the minds of the participants. However, this was less easily achievable because the participants carried out the testing in small groups of up to five in tandem, on five separate computers. In addition, the schools that kindly provided participants were responsible for organising the time that their students were made available. They were keen for the experiment to be completed within the constraints of their timetable which, in this experiment, precluded some of the more individualised questioning that might have been useful.

- The gathering of the results was easily achieved and the analysis followed smoothly. One of the aspects not designed into the research, was an exploration of eye scanning movements between the analogue and digital presentation to measure and track the observation pathway. This would have potentially provided further evidence of the tracking process adopted in tackling time problems. This may have revealed differences between dyslexic and control approaches.

- Further analysis on children's time telling, to measure the role of time related vocabulary in time telling, might present a notable difference between the dyslexic and non-dyslexic. Was there any internalisation of vocabulary? If the participants spoke internally to themselves, then they may well have used that as a modality that helped support what they were doing. Would that contribute towards their memory of the information? It would have been interesting, for instance, to have designed the research to explore the vocabulary that they had used to help them along.

- The performance difference of the 14 year old group is better than that of the 11 year old age group, suggesting that the extra years have enabled more repetition to take place, which has been of greater benefit to the dyslexic group. The procedural learning deficit as evidenced by Nicolson, Fawcett, Brookes, and Needle (2010), suggests that if dyslexics present a defective procedural memory, then automatisation is not achieved so they are likely to resort to first principles in their learning, which slows proceedings down and affects accuracy. Longitudinally, evidence has emerged in providing support showing that older dyslexics continue to be weaker than their counterpart non-dyslexics, though the gap in performance narrows at age 14 years. It would be interesting, therefore, to carry out observations of this trend for improvement between the groups into early adulthood. This would give practitioners an insight into the needs of their older students in telling time. There is evidence to suggest that the younger adult dyslexics continue to experience difficulties telling time and developing time management skills, which might relate to the underperformance of the 14 year old dyslexic group in the time telling task.

- One possible limitation of the research is that, despite checks, it is not certain that all participants had dyslexia only, since co-occurrences may have existed but not have been formally identified. Equally, a measure of co-occurring mathematical difficulties without time telling would provide a more precise measure of the participants taking part. The researcher sought to ensure that no participant had identified AD(H)D, which was checked on a formal basis by the school advising the researcher of any known diagnosis. However, participants may have had other learning issues without their or others' knowledge.

- In addition, a control group matched with the dyslexics on reading rather than spelling could have been incorporated into the design, as is an increasingly common practice.

- A positive critique was that the programme worked well in capturing the participants' broad range of likely age-appropriate knowledge. The general feedback from participants was that they enjoyed tackling the questions. Each trial did not take too long (about 10-15 minutes) to administer. The time on the clock face was clearly visible and the preamble to confirm understanding encouraged enthusiasm for the task. Each participant received a certificate after the event by way of thanks for their input. The research was received in a positive light by both participants and teachers.

- On a statistical basis, the choice of youngsters was a successful fit to the matched pairs quota sampling of dyslexic and control participants.

7.2 Impact on Teaching Time

Time telling is a demanding process for children because of the volume of information concisely presented by a clock. The findings of this research illustrate the level of difficulty experienced by dyslexic children and adults in mastering the process.

The 'physical' considerations presented in the literature review, relating to the dyslexic syndrome, apply to this research. These concern processing speed, memory for time, automaticity of retrieval and rapid naming which were summarised in Chapter 6.

What is interesting is the impact this research could have on the programme of teaching time telling. Likewise, teaching approaches could be modified to achieve an improvement in time telling performance by children. The suggestions made are related to the teaching of dyslexic children, though are equally relevant to a non-dyslexic child.

This research together with other research in time telling (Burny et al., 2011; Friedman & Laycock, 1989), suggests that acquisition in analogue time is achieved by early teens. In the case of dyslexia, however, there is a delay extending beyond this developmental phase.

- It should not be assumed that dyslexic students will achieve the same level of mastery as non-dyslexic students at an age that the teacher feels appropriate.

- Judging by the "Key Stage" expectations for time telling, it would appear that attempting to teach eight and nine year old dyslexics complex times would be difficult and so it should be recommended to teachers that dyslexic children need differentiated work.

- For successful development of time telling skill, the plethora of information regarding time should be presented in a sequential fashion as depicted by the Numeracy Strategy. However, more emphasis should be placed on the early stages of time telling to enable a thorough grounding for the dyslexic children, from which to build. To do this, a multi-sensory approach should be adopted for maximum effect, with smaller incremental teaching steps. A method adopted in literacy teaching is the use of flashcards which helps youngsters to develop a memory for letter sound linkages. This approach would be appropriate in helping dyslexic children to acquire time telling knowledge and to retain it.

- An example of the difference between the dyslexic and control cohorts depicting the development of time can be seen in the simple clock face analysis (3.5.2). This shows that the dyslexics' development in accuracy continues through to the age of 14 in such a way that they are continuing to learn the subject. This contrasts with the non-dyslexic group who are consolidating their knowledge from beyond the age of 11. Therefore, it is essential that to achieve a level of consolidation, the dyslexic child should receive much more instruction which targets the intricate changes between the complexity levels that exist in time telling. The material, therefore, should be cumulative and appropriate in developing skill, and more time should be devoted to the learning of time for improvement.

- It would appear, and this applies more to the findings of the adult questionnaire, that general knowledge about time remains weak even into adulthood. This needs to be addressed during the early stages of time telling and can be easily incorporated into the flashcard memory technique as part of the teaching programme.

- The establishment of careful and structured presentation of time will enable common errors, which appear in time telling, to be managed. Inaccuracies in exact time telling and the process of rounding when describing time need careful teaching. It was difficult to tell from the Time Comparison Task experiment whether some aspects of inaccurate rounding took place when children answered the questions under timed conditions.

- Emphasis should also be placed by teachers on multiplication fact understanding and, in particular, the accurate retrieval of the five times table. This can be incorporated amongst other strategies in helping children to develop their skills cumulatively. These strategies may include using anchor points around the clock, from which to work.

- Within the classroom, standardisation of clock design should be encouraged and teachers should make parents aware that consistency in analogue clock design for younger children is important, to enable skills to be transferred without the need for any additional deciphering. Some parents have on display at home, analogue clocks with Roman numerals.

- Children should be encouraged to observe school bells or school movement around lesson change-overs, with specific clock times as an aide memoir.

- Teachers and parents should encourage young children to develop their own time management skills through independent guidance. Long-term it is anticipated that this type of approach will help young adults to develop time management approaches much more easily.

- Time management skills should be taught in a deliberate sense from an early age to help with long-term time understanding.

In summary, for effective time understanding, it is essential that dyslexic children gain more practice in developing skills so that the many permutations of the clock may be recognised and recalled from memory quickly. Time should be given to the subject of “time” to enable a thorough grounding to be achieved as early as possible in a child’s academic career. The success of this approach will, in the researcher's opinion, help with longer term issues such as time management, self-esteem, and confidence in the life-skill of time telling.

7.3 Adult Time Management Critique

The adult questionnaire was a thorough method by which to evaluate the difference in time management processes between dyslexic and non-dyslexic participants. The mix of questions followed a simple longitudinal structure and gave participants the opportunity to reply to in-depth questions relevant to time management. Having devised a questionnaire, gathered in the responses, conducted both qualitative and quantitative analysis and reported the results, the following thoughts became evident.

- The researcher underestimated the difficulty of encouraging people to take part and it became necessary to make repeated requests for responses from a minority of participants.

- Some questions were a little ambiguous and relied on open-ended responses to glean information, thus making the data analysis more difficult to categorise and analyse. The research project provided an opportunity to perform both qualitative and quantitative analysis, where the former content analysis was the most difficult. This was due to being able to tease out what the respondents were really trying to say in their written responses. It may have been more helpful to have interviewed participants so as to be able to take interesting points further and to alleviate any uncertainties on their part regarding the intent of the questions. Furthermore, the dyslexic participants interpreted some questions differently from the non-dyslexics, for example showing a more literal approach in their response. Although trialled on five adult participants to confirm the reliability of the questions, some "live" participants found various questions ambiguous to answer and required even further clarity. This applied in particular to the dyslexics who brought a plethora of experience to the question, which was too broad for them to be specific. While they responded to the best of their ability, the relevance of some dyslexic responses to such questions was immersed amongst non-relevant information. This was seen as a means of them seeking to provide a thorough response through producing quantity rather than quality.

- The younger adult participants were able to remember what they found difficult at school when it came to mathematics and therefore gave more insightful answers based on more recent, vivid memories. The questions asked in the questionnaire relating to school career, may have benefited from being more specific in helping the older participants answer explicitly, as their memory for school may have faded.

- As relayed in the discussion, further interesting analysis could be carried out on dyslexic and non-dyslexic adults into time management, to determine if there is evidence of greater time discounting and a prevalence of planning fallacy and putting off to the last minute tasks which are demanding. As Koch and Kleinmann (2002) state: “Urgency is so powerful because of the extent of discounting, whereas importance loses its power over time” (p. 207).

- It would be interesting to further investigate possible reasons for a planning fallacy, such as quality of prediction using reflection of the past and application, by applying knowledge of a similar experience to the present one and measuring the outcome.

- Perhaps universities should promote classes in goal-setting and time-management skills. Indeed, this knowledge should not be limited to university but should be presented when training adults generally in the workplace (George et al., 2008).

- Perhaps assessment of a student’s ability to manage time effectively should be measured as part of their entrance standards (George et al., 2008).

7.4 Impact on Time Management

Time management can be demanding for adult dyslexics. The findings of the questionnaire helped to quantify and qualify the areas of difficulty that dyslexics appear to show.

The “physical” manifestation of dyslexia remains the same as in children, such that the adults find it difficult to process times of events and memory for time phases, as outlined in Chapter 5 (Q3.8). The familiarity of events in a year and general knowledge of time such as days in a year, the sequence of months, and the knowledge of leap years, for example, remains problematical for the dyslexic adults. Consequently, establishment of this kind of information needs to take place while at school.

- For adults, proficiency in time management leads to a feeling of greater command in the planning and execution of tasks. Therefore, to improve time management skill by teaching adults time management techniques as part of their personal development might have the added impact of improving skills such as time estimation and time planning.

- It would be beneficial for adults to learn about topics such as time discounting and planning fallacy as part of their skill development. Also, to impart the importance of strategies that work, such as goal setting, will help dyslexic adults to perform better at time management tasks.

- In adult training for task planning, it may be useful for a pro forma of planning structure to be devised. In the same way that an apprenticeship teaches skills in performing a task of work, to incorporate a time management component within an apprenticeship profile may help in long-term estimation of tasks.

- The literature review highlighted the importance of confidence and motivation in achieving goals and, to that end, dyslexic adults should be in a position to receive as much help as they need, to complete their work.

- Account should be taken by teachers and employers of the likely additional stress that dyslexic adults might experience if they find they are overwhelmed by the expectations of the job.

- To achieve control and to maintain it, consideration should be made for the dyslexic adult to be able to prepare in advance of any forthcoming event. In that way, accommodations can be made which would be welcomed.

- The adult research revealed that timetables can pose a problem and so a universal presentation could be considered as a way of simplifying notation and presentation to make the understanding easier for dyslexics.

7.5 Future Research

The sphere of time telling is quite extensive when considering the mechanics involved with the process. It is a task which dyslexics find more difficult to master over a longer period of time. There is much to be investigated to determine specific strategies that dyslexic children use, to compare them with those taught and those which are used by non-dyslexics.

Further investigation of the analogue clock to establish times which are most vulnerable to dyslexic children would help in devising a more suitable research led curriculum and aid understanding.

The use of clock drawing is helpful in establishing weaknesses in an individual's cognitive profile. It would be interesting to establish if reaction time and accuracy of clock identification could be used in a diagnosis of dyslexia, such that it separates other co-occurring learning difficulties like AD(H)D or mathematics difficulties.

This research established that there is improvement in time telling with age, and so this could be explored further to investigate skill development into early adulthood as a means to monitor continuing improvements.

As there is a plethora of language accompanying time telling, further research could be pursued to investigate acquisition and retrieval of relevant language to help hone the skills for the dyslexic. In a similar vein, with reference to the adult population, what current life skills in time telling or management are used in daily life and how successful has this acquisition been for dyslexics and non-dyslexics?

It is hoped that early detection and therefore early remediation would promote confidence and success with the subject of time telling or management and so all these aspects could be studied using age benchmarks to determine differences. It appears that different ages experience different difficulties, which leads on to the adult population who may not yet have gained from research findings. Their remediation may take a different form and should be sympathetic to the needs of the adult learner.

Stress is made reference to by the dyslexic participants, and this might be brought on by time constraints in activities such as taking tests or examinations. Could there be a physical explanation for this situation examined through brain activation research? What measures could be taken to train dyslexics to overcome stress occurrences, or what changes to testing practice could usefully be adopted to enable the dyslexics to perform at their best?

Dyslexia and time research is in a relatively embryonic stage in comparison to the discoveries with dyslexia and literacy but it seems that there is far more to dyslexia than literacy difficulties and it is hoped that this research will help to increase understanding more fully.

7.6 Justification

The researcher believes that this thesis helps in understanding the differences between dyslexic and non-dyslexics in time telling and time management, which will enable more appropriate support in the classroom and in the work environment.

Though improvements are presented, this thesis makes a contribution which is both original and noteworthy. The knowledge gained helps in providing a more thorough background to the difficulties experienced by dyslexic individuals in telling time and time management processes, which has not yet been undertaken in the published literature.

Further, the outcomes presented by this thesis will help to hone the ethos of the Equality Act 2010 to assist educators and employers to understand how dyslexia can affect individuals, and encourage them to consider and implement reasonable adjustments in the educational and workplace setting.

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Appendices

Appendix A: Participant Details

Participant Details for the Time Comparison Task Experiment

Dyslexic Group – 7 year olds, 11 year olds, 14 year olds

Key:

Year & Month	=	Chronological age
Months	=	Age in Months
SAgeComp	=	Spelling Age in Years and Months
IQ Raven	=	Intelligence Quotient
BDTScore	=	Bangor Dyslexia Test Score
MentAge	=	Mental Age in Months
Gender	=	Male or Female

Appendix A.1 7 Year Old Dyslexic Group

Table A. 1

Participant	Year	Month	Months	SAgeComp	IQRaven	BDTScore	MentAge	Gender
81	7	11	95	5.9	103	8.5	98	Male
83	7	9	93	6.9	112	7.0	104	Male
85	7	11	95	6.7	131	5.0	124	Male
89	7	6	90	7.5	122	5.5	110	Male
91	7	6	90	7.6	122	9.0	110	Male
93	7	6	90	7.7	126	5.5	113	Male
95	7	3	87	6.8	114	5.5	99	Male
97	7	8	92	7.9	125	5.5	115	Male
103	7	1	85	7.3	135	5.5	115	Male
105	7	4	88	6.5	119	6.0	105	Male
107	7	0	84	6.6	110	8.0	92	Male
109	7	9	93	6.6	105	5.0	98	Male
111	7	2	86	8.2	131	4.5	113	Male
113	7	0	84	7.1	120	4.5	101	Male
115	7	8	92	7.9	121	4.5	111	Male
119	7	3	87	6.4	117	4.5	102	Male
87	7	5	89	7	122	5.5	109	Female
99	7	11	95	8.3	126	5.5	120	Female
101	7	4	88	7.1	126	6.0	111	Female
117	7	6	90	8.3	131	4.5	118	Female
		Mean	7.50	7.1	121.0	6		
		SD	3.54	8.26	8.71	1.37		

Appendix A.2 11 Year Old Dyslexic Group

Table A.2

Participant	Year	Month	Months	SAgeComp	IQRaven	BDTScore	MentAge	Gender
43	11	10	142	9.2	112	7.5	159	Male
45	11	10	142	7.6	125	7.5	178	Male
47	11	3	135	7.7	112	8.5	151	Male
49	11	9	141	10.6	122	7.0	172	Male
51	11	3	135	9.8	125	6.5	169	Male
53	11	4	136	7.2	112	8.0	152	Male
55	11	4	136	7.5	112	8.0	152	Male
59	11	6	138	9.6	107	8.0	148	Male
65	11	5	137	7.8	105	9.0	144	Male
67	11	5	137	7.6	116	8.0	159	Male
69	11	4	136	10	124	7.5	169	Male
71	11	11	143	8.3	110	5.5	157	Male
73	11	6	138	8	106	8.5	146	Male
75	11	1	133	11.2	125	5.0	166	Male
77	11	7	139	11.1	122	4.5	170	Male
41	11	2	134	7.9	112	8.0	150	Female
57	11	6	138	10.1	122	4.5	168	Female
61	11	3	135	9.9	124	5.5	167	Female
63	11	8	140	9.9	122	5.5	171	Female
79	11	0	132	9.6	112	8.0	148	Female
		Mean	11.45	8.98	116.0	7.0		
		SD	3.08	15.56	7.06	1.48		

Appendix A.3 14 Year Old Dyslexic Group

Table A.3

Participant	Year	Month	Months	SAgeComp	IQRaven	BDTScore	MentAge	Gender
3	14	0	168	11.1	112	7.5	188	Male
5	14	0	168	10.5	108	6.0	181	Male
7	14	7	175	10.3	115	7.5	201	Male
9	14	9	177	8.1	115	7.0	204	Male
13	14	2	170	8.6	106	9.0	180	Male
15	14	9	177	8	99	6.0	175	Male
17	14	8	176	9.8	108	7.0	190	Male
19	14	4	172	9.9	105	7.5	181	Male
21	14	8	176	7.6	105	7.0	185	Male
23	14	11	179	9.9	112	6.5	200	Male
25	14	5	173	11.3	117	7.5	202	Male
27	14	1	169	7.7	100	5.0	169	Male
29	14	2	170	11.8	100	5.5	170	Male
31	14	6	174	10.4	108	6.5	188	Male
33	14	11	179	12.5	125	6.5	224	Male
35	14	11	179	11.2	119	4.5	213	Male
37	14	11	179	8.8	119	8.0	213	Male
39	14	6	174	9.7	112	6.5	195	Male
1	14	5	173	7.5	112	8.0	194	Female
11	14	5	173	11.1	100	5.0	173	Female
		Mean	14.50	9.8	110	7		
		SD	3.72	18.07	7.26	1.14		

Appendix A.4 7 Year Old Control Group

Table A.4								
Participant	Year	Month	Months	SAgeComp	IQRaven	BDTScore	MentAge	Gender
88	7	1	85	9.8	120	1.5	102	Male
90	7	0	84	9.3	121	1.5	102	Male
92	7	6	90	9.7	121	2.0	109	Male
94	7	10	94	11.4	123	2.0	116	Male
96	7	6	90	10.6	114	2.0	103	Male
98	7	0	84	7.8	115	2.5	97	Male
100	7	9	93	9.0	126	2.0	117	Male
102	7	7	91	10.0	119	3.0	108	Male
104	7	2	86	9.0	120	2.5	103	Male
106	7	11	95	10.6	119	2.5	113	Male
108	7	3	87	8.4	106	1.5	92	Male
110	7	5	89	7.4	98	3.0	87	Male
112	7	1	85	10.5	110	3.5	94	Male
114	7	0	84	9.8	115	2.0	97	Male
116	7	0	84	7.6	113	3.5	95	Male
118	7	2	86	7.7	128	2.0	110	Male
82	7	7	91	8.8	102	3.0	93	Female
84	7	8	92	8.2	112	2.5	103	Female
86	7	0	84	9.5	130	2.0	109	Female
120	7	9	93	10.4	116	1.0	108	Female
		Mean	7.30	9.2	116.0	2.0		
		SD	3.86	13.8	8.18	0.97		

Appendix A.5 11 Year Old Control Group

Table A.5								
Participant	Year	Month	Months	SAgeComp	IQRaven	BDTScore	MentAge	Gender
42	11	11	143	12	105	2.0	150	Male
44	11	7	139	12.8	113	1.0	157	Male
46	11	1	133	11.5	121	2.5	161	Male
48	11	8	140	12.9	108	2.0	151	Male
50	10	11	131	12.5	119	2.0	156	Male
52	11	8	140	11.8	125	3.0	175	Male
54	11	7	139	12.9	112	0.5	156	Male
56	11	3	135	13.2	108	0.5	146	Male
58	11	7	139	13.1	119	1.5	165	Male
60	11	0	132	12.3	107	1.0	141	Male
62	11	8	140	11.5	113	3.5	158	Male
66	11	8	140	12.3	100	1.0	140	Male
68	11	1	133	11.8	117	3.0	156	Male
74	11	2	134	11.6	105	2.5	141	Male
76	11	5	137	11.4	118	3.0	162	Male
78	11	3	135	12.2	122	3.0	165	Male
80	11	8	140	11.9	99	0.5	139	Male
64	11	5	137	12.4	122	2.5	167	Female
70	11	4	136	11.8	124	1.5	169	Female
72	11	3	135	11.1	112	2.5	151	Female
		Mean	11.41	12.08	113.0	2.0		
		SD	3.31	7.27	7.88	0.96		

Appendix A.6 14 Year Old Control Group

Table A.6									
Participant	Year	Month	Months	SAgeComp	IQRaven	BDTScore	MentAge	Gender
4	14	2	170	14	108	1.5	184	Male
8	14	4	172	14.2	119	0.5	205	Male
16	14	8	176	12.9	97	3.5	171	Male
18	14	10	178	13.7	108	2.5	192	Male
20	14	0	168	13.7	100	1.0	168	Male
22	14	3	171	13.9	100	2.5	171	Male
24	14	3	171	14.3	112	0.5	192	Male
26	14	2	170	13.8	117	1.5	199	Male
28	14	0	168	13.3	117	1.0	197	Male
30	14	2	170	12.7	100	3.0	170	Male
32	14	2	170	13.8	110	2.0	187	Male
34	14	11	179	14.2	125	1.5	224	Male
36	14	3	171	14.7	125	1.5	214	Male
40	14	4	172	14.8	112	1.5	193	Male
2	14	2	170	13.3	110	1.0	187	Female
6	14	2	170	14	108	1.0	184	Female
10	14	6	174	13.6	112	2.0	195	Female
12	14	2	170	14.4	96	1.0	163	Female
14	14	11	179	13.8	103	2.5	184	Female
38	14	5	173	13.7	117	1.5	202	Female
		Mean	14.34	13.8	109	2		
		SD	3.39	6.44	8.63	0.81		

Appendix A.7 ADD/ADHD Diagnosis Questionnaire for Schools

Confidential

A.R. Ellis PhD Research

Participants Name:	No:
School Name:	PL2

Do you observe any of the following characteristics in this child?

Please circle the most appropriate response for each item.

1 - Never , 2 - Occasionally, 3 - Often, 4 - Always

Difficulties in telling time	**1**	**2**	**3**	**4**
Problems with punctuality	**1**	**2**	**3**	**4**
Do they rely on you to manage their time	**1**	**2**	**3**	**4**
Disruptive, impulsive, calling out in class	**1**	**2**	**3**	**4**
Day dreams	**1**	**2**	**3**	**4**
Disorganised	**1**	**2**	**3**	**4**
Fails to listen to instruction and act on it	**1**	**2**	**3**	**4**
Restless, fidgety, easily bored	**1**	**2**	**3**	**4**
Finds memorising difficult	**1**	**2**	**3**	**4**
Poor fine motor control and co-ordination - poor handwriting	**1**	**2**	**3**	**4**
Poor gross motor control e.g. difficulties in riding a bike or clumsy	**1**	**2**	**3**	**4**
Poor relationships with adults and teachers	**1**	**2**	**3**	**4**
Antisocial behaviour - lies, bullies	**1**	**2**	**3**	**4**
Poor articulation and delay in acquiring speech	**1**	**2**	**3**	**4**
Excessively active - always on the go	**1**	**2**	**3**	**4**
Poor self image—lacking in self confidence	**1**	**2**	**3**	**4**
Lacking in social skills	**1**	**2**	**3**	**4**
Unable to sustain attention - easily distracted	**1**	**2**	**3**	**4**
Mood swings which are unpredictable	**1**	**2**	**3**	**4**
Determined - goes on and on about things	**1**	**2**	**3**	**4**

Comments and Observations

Appendix A.8 Adult Questionnaire

PhD Adult Questionnaire on Time

Name: ______________________________ *(optional)*

Age: *Please tick your age group*

18 - 25	26 - 34	35 - 44	45 - 54	55 - 64	64+

Male ☐ Female ☐

I am carrying out research for a PhD entitled 'Dyslexia and Time'. This questionnaire is just part of the overall research programme which comprises a computer assessment of children aged 7, 11 and 14, and this questionnaire aimed at the age groups above.
The data will only be used for this research and for the writing of related papers and articles for publication.
The names of the participants will not be published in the thesis and will remain strictly confidential.

As a dyslexic I struggled with time when I was younger and still require help with travel timetables. I have therefore devised these questions on the basis of my own experience. I want to discover if my difficulties were and are common to other dyslexic people and to gain knowledge of your experiences both as a child and as an adult in dealing with time issues.

Could you please answer these questions as fully and frankly as you can. The questionnaire will take approximately 30 minutes to complete.

Thank you in anticipation of your help. *Tony Ellis*

1 General Background Questions

1.1 What do you understand by the term dyslexia? Please state:

____

____

1.2 If you consider yourself to be dyslexic; in what ways emotionally and practically does it affect you?
Please comment:

____

____

1.3 Have you had any detailed assessment carried out by a Psychologist for dyslexia? Yes No

When were you tested?: Month Year

☐☐ / ☐☐☐☐

Were you diagnosed with dyslexia? Yes No
Further comments:

____

1.4 Have you heard of Attention Deficit Disorder (ADD)/ Attention Deficit Hyperactivity Disorder (AD(H)D)? Yes No

1.5 Do you believe that you have Attention Deficit Disorder (ADD)/ Attention Deficit Hyperactivity Disorder (AD(H)D)? Yes No Don't know

2 As a Pupil at School 7– 16 yrs

2.1 As a child who has had the greatest influence on you? Please rate 1 to 5 in order of **1** ***(greatest)*** to **5** ***(least)***

Parent/ Guardian	
Teacher	
Peers	
Siblings	
Other	

Please state:

2.2 Did you have a problem with maths as a child?

Yes No

2.3 Listed below are topic areas in mathematics. Please indicate on the rating scale how hard these topics were for you:

	1 Very easy	2 Easy	3 Slightly easier	4 Neither easy nor hard	5 Slightly harder	6 Hard	7 Very hard
Numbers (multiples, factors, %, decimals, place value)							
Shapes (polygons, geometry, matrices)							
Trigonometry (powers roots, Pythagoras)							
Statistics (probability, standard deviation, mode)							
Graphs (tangents, gradients, equations, plotting)							
Algebra (quadratic equations, simultaneous equations)							

Further comments:

2.4 What were your experiences? **Please comment** on the following:

Memory for Maths eg remembering techniques or operations	
Multiplication Facts (tables) Please indicate which facts - in order of difficulty rate on a scale of 1 ***(very easy)*** - 5 ***(very hard)***	1x, 2x, 3x, 4x, 5x, 6x, 7x, 8x, 9x, 10x, 11x, 12x
Telling time eg reading the clock	
Elapsed time eg timetables, time taken	
Celebrations eg remembering birthdays, lunchtime	

2.5 How did you feel about the difficulties, if any, you had? Please tick as many as are relevant and comment

		Comments
frustrated		
angry		
embarrassed		
stressful		
distress		
baffling		
irksome		

If other feelings applied, please comment:

2.6 Was anyone sympathetic to your difficulties? Please specify

Parent/Guardian	Teacher	Fellow Pupil	Sibling	Other

2.7 How did they help? Please state:

3 Learning Time - as a Pupil at School 7-16 yrs

3.1 As a child, did you find learning time difficult? Yes No

3.2 What did you find difficult about telling time, eg understanding the vocabulary, the clock face etc? Please comment:

3.3 How were you helped with time? Please state:

3.4 What did you find worked for you? Please state:

3.5 At what age did you feel confident at telling the time?

5-6	7-8	9-10	11-12	13-14	14+

3.6 What type of watch / clock helped you to learn the time?

Analogue  Digital 13:20

3.7 In what way did it help?

3.8 Different aspects are listed below. Please indicate on the rating scale how hard these areas of time were for you:

	1 Very easy	2 Easy	3 Slightly easier	4 Neither easy nor hard	5 Slightly harder	6 Hard	7 Very hard
Telling time							
12h clock							
Timetables							
Analogue clock face							
24h clock							
Family birthdays							
Digital clock face							
Days							
Parental pressure							
Seasons							
Years							
Weeks							
Months							
Days in a month							
Peers							
Your birthday							
Elapsed time							

4 Time as an Adult 17+ yrs

As an adult different aspects of time take effect which require understanding and practice.

4.1 As an adult did you or do you have difficulties with time? Please comment:

4.2 Do you understand timetables? Eg. railway, plane or bus

Yes

No If No, what do you find difficult about them? Please comment:

4.3 Are some timetables ***better*** to understand for you than others? Which one (s)?

Rail		Plane		Ferry		Bus	

4.4 If a timetable is difficult to understand do you ask for help? Yes No
Please comment:

4.5 Has time changed for you in any way as you have got older? Yes No
If Yes, how?

5 Day-to-Day Time Management

5.1 What do you understand by the term 'time management'? Please comment:

5.2 Do you have difficulties with organising your time? Please comment:

At Work

5.3 At work do ***you*** have a diary? Yes No If No go to 5.7

5.4 If Yes, do you feel you run it efficiently? Yes No

5.5 What kind of diary do you run? Electronic (Computer/PDA) Paper Both

5.6 Which one do you prefer? Electronic (Computer/PDA) Paper Both

5.7 If No. Is there a diary run for you to book events, scheduling, etc? Yes No

5.8 Who runs your diary? A PA / secretary or spouse / partner or other.
Please comment:

5.9 Do you rely heavily on this help? Why and how?
Please comment:

5.10 Do you adopt special strategies for yourself in organising your time?
Please comment:

At Home

5.11 At home do ***you*** run a diary, Yes No If Yes, is this a different diary? eg social Please comment:

5.12 What kind of diary do you run? Electronic (Computer/PDA) Paper Both

5.13 If No, how do you plan your time?
Please comment:

5.14 Who runs your diary? PA / secretary or spouse / partner or other.
Please comment:

5.15 Do you adopt special strategies for yourself in organising your time?
Please comment:

6 Technology and Time Management

There are now a number of electronic devices available to help manage time. The purpose of these questions is to determine their usage by dyslexic people.

6.1 Do you have any particular problems remembering dates/times of events and attending them? Yes No
Please comment:

6.2 Does this cause you to become anxious, stressed or feel poorly organised in the day?
Please comment:

6.3 Does being organised to remember dates/times of events help you to feel better? eg happier, etc Yes No

Please comment:

6.4 Do you use technology to help organise your time? Yes No

6.5 What do you use? Please indicate:

Computer		Electronic diary		PDA		Message Recorders		Other	

6.6 How does the technology help you to organise your time?

6.7 Does this technology make you feel more in control? Yes No
Please comment further:

7 Career Choice

7.1 What job title do you have?

___

7.2 Briefly, please outline your career path to date:

___

7.3 Why did you take your career path? Please rank from
1 (most important) - **8** (least important) the following influences:

Free Choice		Interest		Encouragement		Parental		Teacher		Skill		Forced Choice		Peers	

Please comment: ___

7.4 Are you pleased with your choice? Yes No
Why? Please state 3 reasons:

___

7.5 Do you feel that your career has been affected by dyslexia? Yes No
How? Please comment:

___

7.6 If you had your time again what changes, if any would, you make?

___

8 Lifestyle

8.1 Has your lifestyle been affected by dyslexia?
Please comment:

___

8.2 Have you made lifestyle changes because of your dyslexia? Yes No

8.3 What lifestyle changes have you made and why?

___

8.4 What advice would you have for other dyslexics?

___

8.5 What are your long term goals?

___

9 Time Observations - On Your Own and Other People's Behaviour

9.1 Do you have any observations of other people and time? Yes No
If Yes, what do you notice, eg punctuality, relaxed attitude?

9.2 Are you a person who is a stickler for punctuality? Yes No
Why?

9.3 Expectation - if you are punctual, do you expect others to be also? Yes No
Why?

9.4 How does it affect you? Please comment:

9.5 Do you have any particular behaviour with time issues, eg over-concern for punctuality, anxiety when time moves on? Yes No

Please describe this behaviour:

9.6 Do you underestimate / overestimate the time to do tasks? Yes No
Please comment:

9.7 Do you prefer set routines? Yes No

9.8 ***At work*** what kind of routines relating to time do you like? Please comment:

9.9 ***At home*** what kind of routines relating to time do you like? Please comment:

9.10 Do you organise other people's time? Yes No

9.11 If Yes, in what way?

9.12 If No, is there a reason for this? Please comment:

10.0 Any other comments you may have regarding time, or additional thoughts and feelings.

Please click on the **'Submit Form'** button at the bottom of this page

Thank you for taking part in this questionnaire.

Submit Form Reset Form

Appendix A.9 List of Schools used in this Research:

Appleford School
Eton End School
Frewen College
Knowl Hill School
Licence Victuallers' School
Long Close School
Mark College
Moon Hall
More House School
Moyles Court
Shiplake College
St George's Junior School, Weybridge
St George's School, Windsor Castle
TASIS American School

Appendix B: Accuracy Results

Appendix B.1: Descriptives Table of Mean Accuracy for Group by Age

Group	Age (years)	Mean %	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	7	43.2	3.3	36.7	49.6
	11	88.2	3.3	81.8	94.7
	14	89.7	3.3	83.3	96.2
Dyslexic	7	37.2	3.3	30.7	43.6
	11	68.1	3.3	61.7	74.6
	14	84.8	3.3	78.4	91.3

Appendix B.2: Independent t-test - Accuracy for 7 Year Old Control Group

Levene's Test for Equality of Variances				t-test for Equality of Means			95% Confidence Interval of the Difference			
		F	Sig.	t	df	Sig. (2-tail)	Mean Diff	Std. Error Diff	Lower	Upper
7 year old	Equal variances assumed	5.634	0.022	7.289	38	.001	0.397	0.054	0.287	0.508
	Equal variances not assumed			7.289	29.80	.001	0.397	0.054	0.286	0.509

Appendix B.3: Independent t-test - Accuracy for 11 and 14 Year Old Control Group

Levene's Test for Equality of Variances				t-test for Equality of Means			95% Confidence Interval of the Difference			
		F	Sig.	t	df	Sig. (2-tail)	Mean Diff	Std. Error Diff	Lower	Upper
11 and 14 year old	Equal variances assumed	1.117	0.297	1.800	38	0.079	0.054	0.030	– 0.006	0.115
	Equal variances not assumed			1.800	36.00	0.080	0.054	0.030	– 0.006	0.115

Appendix B.4: Independent t-test - Accuracy for 11 and 14 Year Old Dyslexic Group

Levene's Test for Equality of Variances				t-test for Equality of Means			95% Confidence Interval of the Difference			
		F	Sig.	t	df	Sig. (2-tail)	Mean Diff	Std. Error Diff	Lower	Upper
11 and 14 year old	Equal variances assumed	0.479	0.492	6.04	38	.001	0.378	0.062	0.251	0.505
	Equal variances not assumed			6.043	37.38	.001	5.276	0.378	0.062	0.251

Appendix B.5: Descriptives Table of Mean Accuracy for Age by Group – Simple Clock Faces Only

Group	Age (years)	Mean %	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	7	50.0	3.5	43.2	56.9
	11	94.1	3.5	87.2	101.0
	14	92.7	3.5	85.8	99.6
Dyslexic	7	40.7	3.5	33.8	47.6
	11	72.0	3.5	65.1	78.9
	14	90.0	3.5	83.1	96.9

Appendix B.6: Descriptives Table of Mean Accuracy for Group by Age – Simple Matched Clock Faces Only

Group	Age (years)	Mean %	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	7	51.3	4.0	43.5	59.2
	11	96.2	4.0	88.3	104.1
	14	94.2	4.0	86.3	102.1
Dyslexic	7	31.8	4.0	24.0	39.7
	11	69.3	4.0	61.4	77.1
	14	92.4	4.0	84.5	100.2

Appendix B.7: Descriptives Table of Mean Accuracy for Group by Quartile – Simple Mismatched Clock Faces Only

Group	Quartile	Mean %	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	1	78.3	3.1	72.2	84.4
	2	80.0	3.0	74.1	85.9
	3	77.1	3.4	70.3	83.8
	4	73.8	3.1	67.5	80.0
Dyslexic	1	65.0	3.1	58.9	71.1
	2	75.0	3.0	69.1	80.9
	3	68.3	3.4	61.6	75.1
	4	74.2	3.1	67.9	80.4

Appendix B.8: Descriptives Table of Mean Accuracy for Group by Quartile – Simple Matched Clock Faces Only

Group	Quartile	Mean %	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	1	80.2	2.4	75.5	84.9
	2	82.5	3.7	75.2	89.8
	3	80.0	3.0	74.1	85.9
	4	79.7	2.7	74.3	85.0
Dyslexic	1	66.0	2.4	61.3	70.7
	2	62.5	3.7	55.2	69.8
	3	65.4	3.0	59.5	71.4
	4	64.0	2.7	58.6	69.4

Appendix B.9: Descriptives Table of Mean Accuracy for Correctness by Quartile for Intermediate Clock Faces

Quartile	Correctness	Mean %	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	Matched	87.1	2.1	83.0	91.2
	Mismatched	85.9	2.2	81.5	90.4
2	Matched	91.3	2.5	86.4	96.1
	Mismatched	60.0	3.8	52.5	67.5
3	Matched	72.5	5.1	62.4	82.6
	Mismatched	76.9	2.4	72.2	81.6
4	Matched	84.4	2.6	79.2	89.5
	Mismatched	73.3	3.1	67.2	79.4

Appendix B.10: Descriptives Table of Mean Accuracy for Group by Correctness for 11 Year Old Age Group - Complex Clock Faces Only

Group	Correctness	Mean %	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Controls	Matched	91.5	4.6	82.2	100.8
	Mismatched	83.7	4.1	75.3	92.1
Dyslexics	Matched	61.3	4.6	52.0	70.6
	Mismatched	69.6	4.1	61.2	78.0

Appendix B.11: Descriptives Table of Mean Accuracy for Group by Correctness for 14 Year Old Age Group - Complex Clock Faces Only

Group	Correctness	Mean %	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	Matched	92.9	2.5	87.8	98.0
	Mismatched	88.6	2.8	82.9	94.3
Dyslexic	Matched	86.4	2.5	81.3	91.5
	Mismatched	82.8	2.8	77.0	88.5

Appendix B.12: Descriptives Table of Mean Accuracy for Group by Complexity for 11 Year Old Age Group - Matched Clock Faces Only

Group	Complexity	Mean %	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Controls	Matched Intermediate	87.9	4.3	.79.3	96.6
	Matched Complex	91.5	4.6	.82.2	100.8
Dyslexics	Matched Intermediate	72.5	4.3	.63.9	81.1
	Matched Complex	61.3	4.6	.52.0	70.6

Appendix C: Reaction Time Results

Appendix C.1: Mean Reaction Time - Group and Age (7 Year Olds Only)

Age	Group	N	Mean (seconds)	Std. Deviation	Std. Error Mean
7 year old	Control	20	9.276	4.9410285	11.048475
	Dyslexic	20	6.738	3.5731662	7.989843

Appendix C.2: Independent Sample t-test - Reaction Time for the Young Age Group (7 Year Olds Only)

		Levene's Test for Equality of Variances		t-test for Equality of Means				95% Confidence Interval of the Difference		
		F	Sig.	t	df	Sig. (2-tail)	Mean Diff	Std. Error Diff	Lower	Upper
7 year old	Equal variances assumed	1.62	.211	1.86	38	.070	2.538	1.364	-.222	5.298
	Equal variances not assumed			1.86	34.6	.071	2.538	1.364	-.231	5.307

Appendix C.3: Descriptives Table of Mean Reaction Time - Group and Age (11 and 14 Year Olds) all Complexity and Correctness Levels

Group	Age (years)	Mean (seconds)	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	11	6.1	.484184	5.1124	7.0411
	14	3.84	.484184	2.87545	4.80412
Dyslexic	11	7.90	.484184	6.9326	8.86128
	14	7.27	.484184	6.3089	8.2376

Appendix C.4: Descriptives Table of Mean Reaction Time - Quartile by Complexity for Matched Clock Faces (11 and 14 Year Olds)

Quartile	Complexity	Mean (seconds)	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	Simple	4.652	2.81	4.091277	5.213761
	Intermediate	2.845	4.53	1.940538	3.750450
	Complex	7.239	5.12	6.216956	8.261240
2	Simple	5.989	5.54	4.882658	7.094371
	Intermediate	6.775	4.74	5.828530	7.720743
	Complex	7.644	4.53	6.739022	8.548183
3	Simple	5.684	4.56	4.772993	6.594418
	Intermediate	7.369	12.13	4.950795	9.786264
	Complex	7.035	4.27	6.183912	7.885603
4	Simple	6.088	5.63	4.965834	7.210858
	Intermediate	5.257	5.66	4.128581	6.384463
	Complex	8.437	5.34	7.371533	9.502140

Appendix C.5: Descriptives Table of Mean Reaction Time - Mismatched Clock Faces Only: Three-way Interaction – Group by Quartile by Complexity

Group	Quartile	Complexity	Mean (seconds)	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	1	Simple	5.409	.494	4.424466	6.393333
		Intermediate	4.479	.458	3.566517	5.391537
		Complex	5.942	.498	4.948604	6.935976
	2	Simple	6.456	.758	4.945229	7.967464
		Intermediate	4.881	.626	3.627752	6.133900
		Complex	6.118	.882	4.359827	7.876359
	3	Simple	4.804	.487	3.833230	5.775092
		Intermediate	6.382	.862	4.662781	8.100230
		Complex	6.114	.587	4.942876	7.285221
	4	Simple	4.171	.502	3.169970	5.171080
		Intermediate	6.806	.976	4.860788	8.751798
		Complex	5.845	.559	4.730017	6.960102
Dyslexic	1	Simple	5.658	.564	4.533979	6.782794
		Intermediate	6.024	.523	4.982236	7.066751
		Complex	7.129	.569	5.994689	8.264640
	2	Simple	6.145	.866	4.418666	7.870625
		Intermediate	6.112	.718	4.681233	7.543724
		Complex	10.296	1.007	8.288160	12.304699
	3	Simple	6.454	.556	5.345323	7.563294
		Intermediate	7.891	.985	5.928129	9.854341
		Complex	8.646	.671	7.308109	9.983505
	4	Simple	6.589	.573	5.446861	7.732503
		Intermediate	8.816	1.114	6.593914	11.038177
		Complex	7.542	.639	6.268020	8.815195

Appendix C.6: Descriptives Table of Mean Reaction Time - Simple Mismatched Clock Faces Only: Marginal Two-way Interaction of Quartile by Group

Group	Quartile	Mean (seconds)	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	1	4.745	.398	3.951835	5.538575
	2	5.364	.623	4.123126	6.604974
	3	4.288	.393	3.504963	5.071425
	4	4.051	.391	3.271954	4.830996
Dyslexic	1	5.818	.398	5.024752	6.611492
	2	6.971	.623	5.730526	8.212374
	3	6.970	.393	6.186986	7.753448
	4	6.855	.391	6.075277	7.634319

Appendix C.7: Descriptives Table of Mean Reaction Time - Intermediate Mismatched Clock Faces Only: Quartile by Group for 11 and 14 Year Olds Only

Group	Quartile	Mean (seconds)	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	1	4.519	.359	3.803241	5.236401
	2	4.414	.500	3.417737	5.410436
	3	5.876	.700	4.481056	7.272485
	4	6.601	.763	5.081006	8.122578
Dyslexic	1	6.490	.359	5.773539	7.206699
	2	6.338	.500	5.342164	7.334863
	3	8.527	.700	7.132244	9.923673
	4	8.880	.763	7.359856	10.401428

Appendix C.8: Descriptives Table of Mean Reaction Time - Group by Quartile Interaction for Complex Mismatched Clock Faces Only

Group	Quartile	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	1	5.351	.400	4.553699	6.150133
	2	5.389	.693	4.008721	6.770429
	3	5.767	.460	4.851157	6.683799
	4	5.493	.437	4.622330	6.364577
Dyslexic	1	7.492	.400	6.693961	8.290394
	2	10.181	.693	8.800593	11.562302
	3	8.894	.460	7.978603	9.811244
	4	7.694	.437	6.822939	8.565186

Appendix D: Adult Questionnaire Results

Appendix D.1: Group Statistics for Question 2.3

Mean Response to Primary Mathematics as a Child on Likert Scale 1-7

	Group	N	Mean	Std. Deviation	Std. Error Mean
Mean of responses	Control	40	3.358	1.60599	.25393
	Dyslexic	43	4.216	1.54860	.23616

Appendix D.2: Independent t-test for Question 2.3

Primary Areas of Mathematics

Levene's Test for Equality of Variances				t-test for Equality of Means					95% Confidence Interval Difference	
	Equal variances	f	Sig.	t	df	Sig. (2-tail)	Mean Diff	Std. Err	Lower	Upper
Numbers (multiples, factors, percentages, place	assumed	.016	.901	-1.1	81	.282	-.473	.437	-1.341	.396
	not assumed			-1.1	79.68	.283	-.473	.438	-1.343	.398
Shapes (polygons, geometry, matrices)	assumed	1.35	.248	-1.8	80	.084	-.866	.495	-1.851	.119
	not assumed			-1.8	78.28	.085	-.866	.496	-1.854	.122
Trigonometry (powers, root, Pythagoras)	assumed	.396	.531	-2.5	81	.016	-.966	.393	-1.747	-.184
	not assumed			-2.5	80.79	.016	-.966	.392	-1.746	-.185
Statistics (probability, standard deviation, mode)	assumed	1.72	.194	-1.4	81	.170	-.567	.410	-1.383	.248
	not assumed			-1.4	80.64	.168	-.567	.408	-1.379	.244
Graphs (tangents, gradients, equations, plotting)	assumed	.098	.755	-2.9	79	.004	-1.30	.441	-2.179	-.422
	not assumed			-2.9	78.98	.004	-1.30	.440	-2.176	-.425
Algebra (quadratic equations, simultaneous equations)	assumed	.008	.927	-2.1	80	.039	-.924	.439	-1.798	-.049
	not assumed			-2.1	79.437	.039	-.924	.439	-1.798	-.050

Appendix D.3: Group Statistics for Question 2.4

Mean Score for the Multiplication Rating Scale

	Group	N	Mean	Std. Deviation	Std. Error Mean
Mean of multiplication Number Facts	Control	39	1.694	.78972	.12646
	Dyslexic	42	2.289	.85247	.13154

Appendix D.4: Independent t-test for Question 2.4

Multiplication Number Fact Analysis

Levene's Test for Equality of Variances				t-test for Equality of Means					95% Confidence Interval of the Difference	
	Equal variances	F	Sig.	t	df	Sig. (2-tail)	Mean Diffce	Std. Error	Lower	Upper
Average of multiplication facts	assumed	.446	.506	–3.25	79	.002	-.595	.18299	-.959	-.231
	not assumed			–3.26	79	.002	-.595	.18247	-.958	-.232

Appendix D.5: Group Statistics for Question 3.8

Different Aspects of Time

	Group	N	Mean	Std. Deviation	Std. Error Mean
Average	Control	39	4.9267	1.92749	.30865
	Dyslexic	43	6.7475	2.79000	.42547

Appendix D.6: Independent t-test for question 3.8

Different Aspects of Time

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
	Equal variances	**F**	**Sig.**	**t**	**df**	**Sig. (2-tail)**	**Mean Difference**	**Std. Error Diffce**	**Lower**	**Upper**
Average	assumed	5.182	.026	–3.404	80	.001	–1.82077	.5349	–2.89	–.756
	not assumed			–3.464	74.91	.001	–1.82077	.5256	–2.87	–.774

Appendix D.7: Group Statistics for Question 3.8 Time Phases

	Group	N	Mean	Std. Deviation	Std. Error Mean
Time Phases	Control	39	2.2179	1.04601	.16750
	Dyslexic	43	3.4674	1.40012	.21352

Appendix D.8: Independent t-test for question 3.8 Time Phases

	Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
Equal variances	F	Sig.	t	df	Sig. (2 tail)	Mean Difference	Std. Error Difference	Lower	Upper
assumed	4.687	.033	–4.54	80	.001	–1.2495	.27520	–1.7976	–.7018
not assumed			–4.60	77.260	.001	–1.2495	.27137	–1.7898	–.7092

Appendix D.9: Group Cross Tabulation Question 4.1

As an adult do you have difficulties with time? Comments

			No	Yes -- time management	Yes -- dates, days, elapsed time	Yes 24 hour	Total
Group	Control	Count	33	6	0	2	41
		Expected Count	29.3	8.8	1.0	2.0	41.0
		% within Group	80.5%	14.6%	.0%	4.9%	100.0%
		% within As an adult do you have difficulties with time? comments	55.0%	33.3%	.0%	50.0%	48.8%
		% of Total	39.3%	7.1%	.0%	2.4%	48.8%
	Dyslexic	Count	27	12	2	2	43
		Expected Count	30.7	9.2	1.0	2.0	43.0
		% within Group	62.8%	27.9%	4.7%	4.7%	100.0%
		% within As an adult do you have difficulties with time? comments	45.0%	66.7%	100.0%	50.0%	51.2%
		% of Total	32.1%	14.3%	2.4%	2.4%	51.2%
Total		Count	60	18	2	4	84
		Expected Count	60.0	18.0	2.0	4.0	84.0
		% within Group	71.4%	21.4%	2.4%	4.8%	100.0%
		% within As an adult do you have difficulties with time? comments	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	71.4%	21.4%	2.4%	4.8%	100.0%

Appendix D.10: Group Cross Tabulation response for Question 4.1

As an adult do you have difficulties with time? Comments

			Group		Total
			Control	Dyslexic	
As an adult do you have difficulties with time? Comments	No	Count	33	27	60
		Expected Count	29.3	30.7	60.0
	Yes	Count	8	16	24
		Expected Count	11.7	12.3	24.0
Total		Count	41	43	84
		Expected Count	41.0	43.0	84.0

Appendix D.11: Question 4.1 Chi-square Test

As an adult did you or do you have difficulties with time?

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-square	3.221[a]	1	.073		
Continuity Correction[b]	2.412	1	.120		
Likelihood Ratio	3.272	1	.070		
Fisher's Exact Test				.093	.060
Linear-by-Linear Association	3.183	1	.074		
N of Valid Cases	84				
a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.71.					
b. Computed only for a 2x2 table					

Appendix D.12: Question 4.4

If a timetable is difficult to understand do you ask for help? Comments

			Group		
			Control	**Dyslexic**	**Total**
If the timetable is difficult do you ask? Comments Total	No	Count	2	3	5
		% within If the timetable is difficult do you ask? Comments	40.0%	60.0%	100.0%
		% within Group	9.5%	12.5%	11.1%
		% of Total	4.4%	6.7%	11.1%
	Yes – as directly without reference timetable	Count	2	9	11
		% within If the timetable is difficult do you ask? Comments	18.2%	81.8%	100.0%
		% within Group	9.5%	37.5%	24.4%
		% of Total	4.4%	20.0%	24.4%
	Yes – lack of confidence	Count	11	9	20
		% within If the timetable is difficult do you ask? Comments	55.0%	45.0%	100.0%
		% within Group	52.4%	37.5%	44.4%
		% of Total	24.4%	20.0%	44.4%
	Yes – if complicated	Count	6	1	7
		% within If the timetable is difficult do you ask? Comments	85.7%	14.3%	100.0%
		% within Group	28.6%	4.2%	15.6%
		% of Total	13.3%	2.2%	15.6%
	Never ask – look stupid	Count	0	2	2
		% within If the timetable is difficult do you ask? Comments	.0%	100.0%	100.0%
		% within Group	.0%	8.3%	4.4%
		% of Total	.0%	4.4%	4.4%
	Count	Count	24	45	69
Total		% within If the timetable is difficult do you ask? Comments	46.7%	53.3%	100.0%
		% within Group	100.0%	100.0%	100.0%
		% of Total	46.7%	53.3%	100.0%

Appendix D.13: Group Cross Tabulation Diary at Work - Yes No response for Question 5.3 At work, do you have a diary?

		Diary at work - Yes No		Total
Count		Yes	No	
Group	Control	25	13	38
	Dyslexic	27	13	40
	Total	52	26	78

Appendix D.14: Frequency Analysis for Question 5.10

Do <u>you</u> adopt special strategies for yourself in organising your time?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	24	28.6	42.1	42.1
	Yes – Target, Prioritise	8	9.5	14.0	56.1
	Yes – Notes, to do lists, post-it notes	10	11.9	17.5	73.7
	Yes – Colour codes, Mind maps	2	2.4	3.5	77.2
	Yes – 3rd party help	1	1.2	1.8	78.9
	Yes – Careful planning	8	9.5	14.0	93.0
	Yes – Rewards for achievements	1	1.2	1.8	94.7
	Yes – Spread appointments	2	2.4	3.5	98.2
	Yes – Use technology for storage	1	1.2	1.8	100.0
	Total	57	67.9	100.0	
Missing		27	32.1		
Total		84	100.0		

Appendix D.15: Chi-square Tests for Question 6.1

Do you have any particular problems remembering dates / times of events and attending them?

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	10.906[a]	2	.004
Likelihood Ratio	11.322	2	.003
Linear-by-Linear Association	.019	1	.890
N of Valid Cases	84		
a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .98			

Appendix D.16: Chi-square Test for Question 6.2 Collapsed Data.

Does this cause you to become anxious, stressed or feel poorly organised in the day? Please comment.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-square	5.959[a]	1	.015		
Continuity Correction[b]	4.649	1	.031		
Likelihood Ratio	6.003	1	.014		
Fisher's Exact Test				.023	.015
Linear-by-Linear Association	5.847	1	.016		
N of Valid Cases	53				
a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.72.					
b. Computed only for a 2x2 table					

Appendix D.17: Frequency Analysis for Question 6.3

Does being organised to remember dates / times of events help you to feel better? Yes No

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Yes**	79	94.0	94.0	94.0
	No	3	3.6	3.6	97.6
	Missing	2	2.4	2.4	100.0
	Total	84	100.0	100.0	

Appendix D.18: Group Cross Tabulation for Question 6.3

Does being organised to remember dates / times of events help you to feel better? Yes No

		Group		Total
		Control	Dyslexic	
Does being organised help you to feel better? Comments reduced	relaxed, confident	10	13	23
	Control	12	16	28
	Total	22	29	51

Appendix D.19: Chi-square Test for Question 6.3

Does being organised to remember dates / times of events help you to feel better? Yes No

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-square	.002[a]	1	.964		
Continuity Correction[b]	.001	1	1.001		
Likelihood Ratio	.002	1	.964		
Fisher's Exact Test				1.001	.594
Linear-by-Linear Association	.002	1	.965		
N of Valid Cases	51				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.92.
b. Computed only for a 2x2 table

Appendix D.20: Group Cross Tabulation for Question 6.4

Do you use technology to help organise your time? Yes No

		Group		Total
		Control	Dyslexic	
Do you use technology to help you? Yes no	Yes	15	14	29
	No	25	28	53
	Total	40	42	82

Appendix D.21: Chi-square Tests for Question 6.4

Do you use technology to help organise your time? Yes No

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-square	.156[a]	1	.693		
Continuity Correction[b]	.027	1	.870		
Likelihood Ratio	.156	1	.693		
Fisher's Exact Test				.818	.435
Linear-by-Linear Association	.154	1	.695		
N of Valid Cases	82				
a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.15.					
b. Computed only for a 2x2 table					

Appendix D.22: Group Cross Tabulation for Question 6.5

What do you use? Please indicate: Computer, PDA, Message Recorder, Electronic diary, other

		Group		Total
		Control	**Dyslexic**	
What do you use? Computer, PDA, Message Recorder, Electronic diary, other	Computer	3	3	6
	PDA	1	0	1
	Message Recorder	0	1	1
	Electronic Diary	3	9	12
	Other	0	3	3
	Total	7	16	23

Appendix D.23: Group Cross Tabulation for Question 7.1 Career Choice

What job title do you have?

		Group		Total
		Control	**Dyslexic**	
Academic or Practical	Academic	15	13	28
	Practical	20	30	50
	Total	35	43	78

Appendix D.24: Dyslexic Group Career Path Mean Ranking for Question 7.3

	Mean Rank
1. Why did you take your career path? Interest	2.89
2. Why did you take your career path? Free choice	3.19
3. Why did you take your career path? Skill	3.44
4. Why did you take your career path? Encouragement	4.06
5. Why did you take your career path? Parental	4.44
6. Why did you take your career path? Peers	5.35
7. Why did you take your career path? Teacher	6.22
8. Why did you take your career path? Forced choice	6.41

Appendix D.25: Frequency Table for Question 7.5

Do you feel that your career has been affected by dyslexia? Yes No

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	30	35.7	39.5	39.5
	No	46	54.8	60.5	100.0
	Total	76	90.5	100.0	
Missing			8	9.5	
	Total	84	100.0		

Appendix D.26: Group Cross Tabulation for Question 8.1

Has your lifestyle been affected by dyslexia?

		Group		Total
		Control	**Dyslexic**	
Has your lifestyle been affected by dyslexia? reduced	No	27	26	53
	Yes	3	16	19
	Total	30	42	72

Appendix D.27: Frequency Table for Question 8.2

Have you made lifestyle changes because of your dyslexia? Yes No

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	11	13.1	17.5	17.5
	No	52	61.9	82.5	100.0
	Total	63	75.0	100.0	
Missing		21	25.0		
	Total	84	100.0		

Appendix D.28: Frequency Table for Question 8.4

What advice would you have for other dyslexics?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Early testing/diagnosis	5	6.0	11.4	11.4
	1-2-1 tuition	1	1.2	2.3	13.6
	Get help and support	15	17.9	34.1	47.7
	Take control, have confidence and never give up!	15	17.9	34.1	81.8
	Devise techniques to suit yourself	6	7.1	13.6	95.5
	Work to your strengths	2	2.4	4.5	100.0
	Total	44	52.4	100.0	
Missing		40	47.6		
	Total	84	100.0		

Appendix D.29: Group Cross Tabulation for Question 9.1

Do you have any observations of other people and time?

		Group		Total
		Control	Dyslexic	
Observations of other people and time? Yes no	Yes	26	35	61
	No	10	6	16
	Total	36	41	77

Appendix D.30: Group Cross Tabulation for Question 9.1

Do you have any observations of other people and time? Open-ended question collapsed

		Group		Total
		Control	Dyslexic	
Observations of other people and time? Comments Reduced	No concept of time	1	0	1
	Poor time management	4	7	11
	Yes – time management made easy by some	3	6	9
	Yes – some are too relaxed	4	6	10
	Punctuality – always late	4	3	7
	Punctuality – always early	4	5	9
	Other	3	3	6
	Use time effectively	0	2	2
	Rushing	1	0	1
	Discourteous	1	1	2
	Total	25	33	58

Appendix D.31: Group Cross Tabulation for Question 9.2

Are you a person who is a stickler for punctuality? Why?

		Group		Total
		Control	Dyslexic	
Are you punctual? Yes No	Yes	25	30	55
	No	14	12	26
	Total	39	42	81

Appendix D.32: Group Cross Tabulation for Question 9.3

Expectation – if you are punctual, do you expect others to be also? Why?

		Group		Total
		Control	Dyslexic	
Do you expect others to be punctual? Yes No	Yes	30	33	63
	No	8	8	16
	Total	38	41	79

Appendix D.33: Group Cross Tabulation for Question 9.3 Collapsed Expectation - if you are punctual, do you expect others to be also? Why?

		Group		Total
		Control	Dyslexic	
Do you expect others to be punctual? Why? Comments Reduced	Hate lateness	2	3	5
	Rude	9	7	16
	Politeness	3	10	13
	Reciprocal effect	5	6	11
	Frustratingly, angry, stressed	2	1	3
	Total	21	27	48

Appendix D.34: Group Cross Tabulation for Question 9.4 How does it affect you? Comment

		Group		Total
		Control	Dyslexic	
How does punctuality affect you? Reduced	Doesn't	8	6	14
	Moaned at	1	2	3
	Annoying, frustrating, stress	17	16	33
	Try to be early	2	5	7
	Affected my time and planning	2	3	5
	Don't like being kept waiting	0	4	4
	Total	30	36	66

Appendix D.35: Group Cross Tabulation for Question 9.5 Collapsed

Do you have any particular behaviour with time issues?

		Group		Total
		Control	Dyslexic	
Do you have any particular behaviour with time issues? Reduced	No	3	3	6
	Yes – always in a hurry/hate to be late	5	9	14
	Yes	1	4	5
	Cross and angry	2	2	4
	Anxious and stressed	5	2	7
	Running out of time	3	2	5
	Total	19	22	41

Appendix D.36: Frequency Table for Question 9.6

Do you underestimate/overestimate the time to do tasks?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	48	57.1	64.0	64.0
	No	27	32.1	36.0	100.0
	Total	75	89.3	100.0	
Missing		9	10.7		
	Total	84	100.0		

Appendix D.37: Group Cross Tabulation for Question 9.6 Collapsed

Do you underestimate/overestimate the time to do tasks?

		Group		Total
		Control	Dyslexic	
Time estimation, underestimate/ overestimate? Comments	No	3	2	5
	Overestimate	11	15	26
	No problem estimating	3	1	4
	Underestimate	9	12	21
	Both	3	1	4
	Total	29	31	60

Appendix D.38: Group Cross Tabulation for Question 9.7
Do you prefer set routines?

		Group		Total
		Control	Dyslexic	
Do you prefer set routines? Yes No	Yes	25	26	51
	No	14	16	30
	Total	39	42	81

Appendix D.39: Group Cross Tabulation for Questions 9.8 and 9.9 Collapsed At work/home what kind of routines relating to time you like? Comments

		Group		Total
		Control	Dyslexic	
At work / home what kind of routine's relating to time you like? Comments Reduced	No – routine	3	7	10
	No – not keen	1	4	5
	Yes	20	20	40
	Yes – like it	6	7	13
	Yes – reluctantly	0	2	2
	No interventions	0	1	1
	Total	30	41	71

Appendix D.40: Chi-square Tests for Question 9.8 Collapsed
At work what kind of routines relating to time do you like? Comments

2x2 Contingency Table	Yes	No	Total
Dyslexic	30	11	41
Control	26	4	30
Total	56	15	71

Chi-square with Yates correction

Chi-square equals 1.170 with 1 degrees of freedom.

The two-tailed *P* value equals 0.2793

The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.

Appendix D.41: Chi-square Tests for Question 9.9 Collapsed

At home what kind of routines relating to time do you like? Comments

2x2 Contingency Table	Yes	No	Total
Dyslexic	24	13	37
Control	27	7	34
Total	51	20	71

Chi-square with Yates correction

Chi-square equals 1.204 with 1 degrees of freedom.

The two-tailed *P* value equals 0.2726

The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.

Appendix D.42: Comments Made by Dyslexic Participants in Response to Question 8.4 "What advice would you have for other dyslexics?"

"It is who you are, don't fight it."

"Try not to let it rule your life, (sic) I have a friend that (sic) says she can't learn to dirve (sic) because shes (sic) dislexic (sic), that's just lazy, just try everything, dyslexia aint (sic) gona (sic) make a difference."

"Don't worry and do ask for help and support."

"1 on 1 tution (sic) is good"

"Know how you learn best, dyslexia is not a curse it's a gift when used right."

"Always ask for help, your (sic) not stupid if you can believe in yourself you can reach what you want to do in life (sic) just find clever ways to do it (sic) working around the normal societal way."

"Get the help when you are yonger (sic) and when at uni (sic) get every bit of extra help as you can."

"Don't know. i (sic) don't really know enough about dyslexca (sic)."

"Overcome the confidence barrier and read more."

"Try not to let it affect your choices."

"Understand your dyslexia. Know what you are good at and what you are not. Pick a career that fits. Develop a working style that fits. Talk to others who have found "a way through."

"There is no cure but there are techniques and methods to make task in hand easier (sic) get tested early."

"Find a system that works for you. Don't be affraid (sic) of telling people as they will understand much more than if you are always making mistakes and making excuses. I once signed a letter off with "Kind Retards"."

"Your (sic) not stupid You (sic) have a lot to offer it just needs to be realised (sic) find something that you really enjoy and prove to yourself that you can achieve."

"Play to your strengths, once you know what they are. Keep challenging yourself to find the best way to learn."

"Don't be affraid (sic) to ask questions. Get 1x1 help if necessary."

"Explore different learning technics (sic)."

"There is more help out there for people now isn't there for those who want it anyway."

"Non-stop reading and learning."

"Be positive - don't be afraid, there are people out there who care and want to aid and assist to overcome this situation."

"Get support as soon and as early as possible."

"For confidence be fully tested and understand what it means - learn skill."

"Always try and do your best."

"Don't put up with it ..... get help."

"Go to specialized classes."

"Try and go through life without trying to hurt anybody."

"To seek help at all opportunities."

"Seek advice and treatment."

"Have patients (sic)."

"Don't be afraid to get help and as soon as possible."

"Just to not feel stupid if you don't understand things. Most people who aren't dyslexic also have difficulties understanding things. It's not just dyslexic people who struggle."

"Work solely on your memory skills as this is the basis of most of my difficulties - once this has been concord (sic) - the rest will come easier."

"Belive in yourself. Don't be ashamed of your dyslexia be proud of it. After all look at what you have achieved against such odds."

"Keep going no matter how difficult the journey and believe in yourself."

"To persevere."

"Looked for alternate ways at understanding problems and situations."

"Find what works for you. It takes a lot of time, that children especially resent. But knowing how you learn and modifying your surroundings to support that learning style is crucial."

"Developing a systematic approach and sticking to it. I liken it to Tiger Woods who always approach (sic) his shots the same way. Familiarity gives the dyslexic the advantage of always starting from the familiar before trying the unfamiliar. Always give tasks your undivided attention especially if you will have to know it at a later date."

"Don't let anyone tell you that you are thich (sic) as you are not but just need more time. A lot of famous achievers are dyslexic!"

"Seek out good advice and consider whether to disclose your difficulties to make life easier. Be proud of your problem, it won't stop you achieving."

"You're not alone."

"…they have a problem not you. you have the gift of a brain that works in a different way to them … use it to you (sic) advantage."

"Do what you are good at, look to your strengths and use them to build upon."

"To get all help available."

"Never give up. Stay positive & cheerful."